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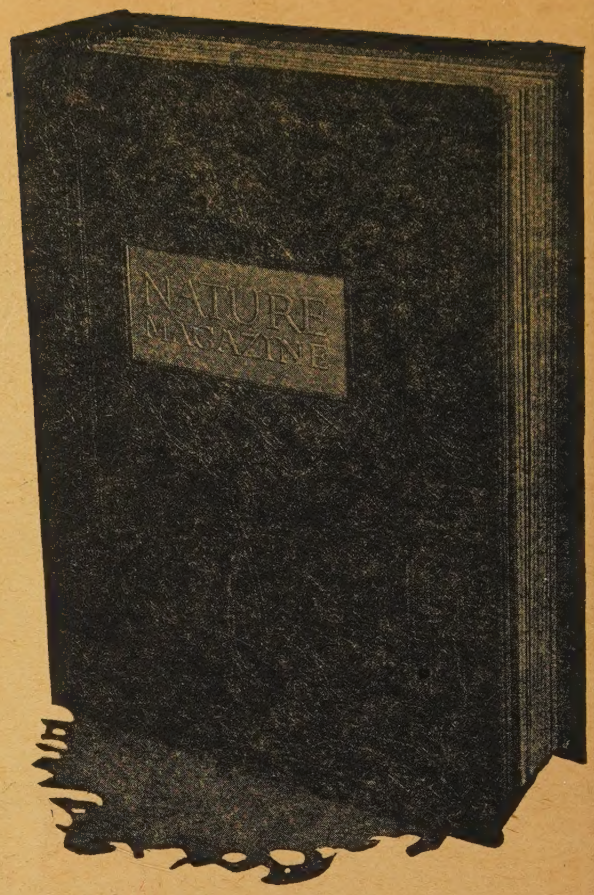

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Forty Ducks to a Gunner

Editor, Nature Magazine:

A little more than a decade ago the first decided restrictions on the killing of waterfowl were written into the Federal regulations. Since then, confident of their managing abilities, the makers of the regulations have in most years liberalized hunting privileges. Like the hog killers and crop-plowers-under, however, the duck planners have been utterly unable to forecast the future and are now faced with a dangerous shortage of waterfowl. In this era of so-called conservation, there is an estimated continental waterfowl population of 80 millions which are being pursued by two million licensed (plus no one knows how many unlicensed) duck hunters.

Thus there are not more than 40 ducks to a gunner. With the bag limit at 7 per day, the hunters, if they could get at the birds, could exterminate the waterfowl in a week. Isn't that taking an undue chance with irreplaceable wildlife? The tendency has ever been to give hunters, not game, the benefit of the doubt, but that is not the course that would be followed if the primary aim were conservation. If we were sincerely trying to achieve real conservation, no chances would be taken. In the present crisis, waterfowl hunting would be stopped. The hunters should have gumption enough to do it even though the leaders fail in wisdom and firmness.

Forty ducks to a man. That is none too many just to look at. If the waterfowl are extirpated, something will be gone that mankind can not replace but which will be greatly missed. The inspiration of the sound of winnowing wings and the sight of sweeping lines and wedges of waterfowl against the sky will be gone forever. Such experiences elevate the spirit beyond appraisal. They are not selfish, the same birds can serve men, many men, over and over again, giving them spiritual lifts that will help them for many a day. Seeing and enjoying waterfowl, thrilling to their splendid beauty and mystery, what a contrast to "reducing to possession" some bloody rags of feathered flesh that can never again be a joy to anyone.

And taking just forty ducks to a gunner this year can eliminate the waterfowl. Have we not gone clear to the verge from which we must absolutely recoil, if we are to deserve in any degree the name of conservationists? MATHEMATICIAN

Garden Plans

"Garden Plans for Low-cost Homes" is the title of a practical little booklet published by the National Garden Institute, 598 Madison Avenue, New York 22, New York. It is designed to be of help to veterans, industrial and office workers, and all those thinking of buying or building a modest home, or improving their home grounds. Copies are available at ten cents each as long as they last.

WE LOVE LIFE

By IRENE BUCHANAN

We were driving from our home in an industrial town to our vegetable garden in the suburbs at a time when factory traffic was heaviest. As we approached an important intersection near the city limits, we realized that traffic was at an inexplicable standstill. We noticed, as we pulled up behind the long string of cars, that everyone was gaping to see what the cause of the delay might be. There was no light at this intersection, but suddenly as if given the green signal, traffic moved smoothly on, while smiling faces protruded from the windows of passing cars.

We came upon the point of interest just in time to see two mother ducks, and a whole platoon of midget puffs, escorted by two fighter drakes, slowly and deliberately waddling into the camouflaged shelter of the grassy roadside, after what had apparently been a successful maneuver. We love life!

Green Centers—Beware!

In a paper on Texas plant names that I edited years ago was the following remark relative to the hard, acorn-like seeds of the American lotus: These "were eaten by Indians and early settlers. The embryonic leaves in the center . . . were always carefully picked out as Indians told white friends they are poisonous." This reminds me of a belief that prevailed in Grant County, Indiana, in my youth. Boys ate the contents of the large, hard seeds of the Kentucky coffee-tree, roasted when they could wait, otherwise raw. These also had a small green embryo in the middle about which the warning passed, "Don't eat that; it will kill you."—*W. L. McAtee.*

Soil Conservation

"Let's Practice Soil Conservation for a Permanent Agriculture" is the plea contained in the title of an excellent booklet recently published by the International Harvester Company, 180 North Michigan Avenue, Chicago 1, Illinois. Graphically, in pictures, maps and drawings, this concise publication presents the problems of soil erosion and the remedies provided by soil conservation. This is a booklet that deserves wide distribution, and it is free on request.

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Nature in Print

By HOWARD ZAHNISER

ONE WONDERS—this Sabbath evening—how much family reading still survives. Thirty to twenty years ago there was no radio as a perpetually tempting visitor to the family circle, and the family then was indeed large enough to form something of a circle. There were fewer automobiles ready to carry the whole family from the home. There were, in fact, few ways to observe the Sabbath without "desecration." Of course there was walking in the woods and fields. And there was reading at home. It is pleasant to recall how often—probably on rainy and stormy days—this reading was family reading. Missionary interests, and the appeal of the far-away, combined to make such books as *The Story of John G. Paton* and *Jock of the Bushveld* ideal both for parental reading and filial listening. It mattered little that the dog Jock moved in no religious setting, for after all his story did have its setting in the great mission field of Africa. It mattered little that John G. Paton was a preacher, for after all the heathen of his New Hebrides field were strange and dangerous "natives." The temptations of the outside world mattered not so much, either, when there was such family reading at home. One wonders—this Sabbath evening—how much of this sort of thing survives, or if it could live again.

Certainly, one whose boyhood was thus enriched both as to family enjoyment and an experience of remote places could hardly spend a Sunday reading Mrs. Akeley's *Rumble of a Distant Drum: A True Story of the African Hinterland,* without placing it in such a setting. How well that title would have stirred those young ears, and how well contrived that subtitle would have been to qualify it for selection! Then, too, there is the thought that Mrs. Akeley herself is thinking of twenty years ago, thinking tenderly, too—writing of the events on her return safari through the African wilderness after the sudden death of her husband "in the gorilla volcanoes of the Belgian Congo."

And the "hero" of her recollections is a ten-year-old Watusi lad, Mihigo, who, on his first meeting with Mrs. Akeley one Christmas Eve (though he did not know it was a Holy Night), placed a basket of strawberries at her feet and "cried, in his shrill treble, 'These are for Memsahib. May she have good health!' "

No juvenile book, this *Rumble of a Distant Drum,* but what school-child's ears will not listen to the tale it has to tell, of how the young Mihigo became Mrs. Akeley's *toto,* and traveled with her through the African equatorial wilderness to the outpost of civilization in Nairobi? And what parent will not follow to the end—with a most mature interest—these recollections of a young and newly bereaved widow pursuing with a brave competence the purposes of her husband's expedition? Or who will not feel the better for having known the real hero of this return expedition—Mrs. Akeley's chief native assistant, Uimbia, to whose memory the book is dedicated:

". . . UIMBIA GIKUNGU, born amid the green Kikuya Hills in the very shadow of Mt. Kenya's snows. Greatest and most courageous of gun boys; wisest of native leaders; outstanding in efficiency, judgment and experience; lavish in loyalty and devotion. Sharing our joy—understanding our grief. . . ."

Nor is *Rumble of a Distant Drum* simply a tale of interesting people; it is also a sophisticated expression of the elemental forces of the primitive environment. Here in the African wilderness, Mrs. Akeley quotes Marshal Smuts as saying, "the human element sinks into utter insignificance, and a subtle Spirit, much older than the human spirit, grips you and subdues you and makes you *one* with itself." Perhaps the sudden grief of one less than two years a bride was the more sensitive to this "subtle Spirit." Perhaps the recollection of bereavement has the more subtly suffused its circumstances with intimations of this elemental force. However explained, this sense of the primitive environment is pervasive, so much so that it seldom requires objective expression. The wilderness is itself a silent character of the book.

And it is plain that Mrs. Akeley respects her native companions not only as individuals but as creatures of, and a part of, this primitive environment. Once she gives poetic expression of her regard for them:

"A singular people, these dark children of the sun! Eerie; surprising in their knowledge of the ways of nature; sometimes even in truce with the wild creatures of the jungle! Wise in their understanding of the minds of white men! Eminently possessed oftentimes of the faculty of intuition! Who indeed are we to call them barbarous? Savage? Yes, perhaps, savage. Beings *at one with the profound mysteries of the forest!*"

The lion, elephant, hippopotamus, and giraffe are here, too, with excitement, but also there are other wild creatures that only the discerning eye of an informed explorer could note, and only a careful and knowing writer could describe. In the midst, for example, of an heroic struggle with tropical heat, Mrs. Akeley records:

"Once, they stopped for several minutes but only for a good reason. From the slope above them, stones and gravel came hurtling down, straight in their path. A small rock slide had started. The cause of it was three dainty antelope, pale gray in color, with a tinge of gold in their shaggy coats, and with small, spiked horns, who were leaping swiftly from rock to rock. These were klip-springer, agile as the wild sheep and goats of the Northern Hemisphere and the chamois of Europe; . . . Even Uimbia exclaimed in surprise."

These wild creatures, these "dark children of the sun," this subtle Spirit of the wilderness are in *Rumble of a Distant Drum* very much a part of the world we all know. It is the most curiously appropriate fact of the book that all of Mihigo's great adventure as a ten-year-old *toto* can be portrayed as the dream of the same Mihigo serving in World War II.

Distraught by the ill-timed illness of his interpreter, a British officer speaks aloud his English worry, and "Corporal Mihigo" approaches:

"Sir, please! . . . I can take orders. I understand English."

". . . do you understand what we've been talking about? Do you know the fix I'm in? That I must get information for the colonel about the position of the Italians? The defenses of the big trading post, Bonga, they took from the Ethiopians?"

"Yes, sir, I understand it. . . . I take two good men. We find out everything in two nights, one day . . . when I was a little boy, ten years of age, I went on a safari with a white memsahib. Her name was Memsahib Akeley. I went with her

I Love Thy World

By M. CLIFFORD HARRISON

I love Thy world when spring is in the air,
When green woods flash with wild azalea's flame;
I love Thy world when winter boughs are bare
Or autumn crimsons glorify Thy name.
I love moss-covered rocks, the mist-cooled dell,
The creek near home when often I have fished,
Old pine-filled fields, blue ocean's lazy swell.
All these to me have yielded what I've wished.
I love long summer days, still starlit nights,
The song of river rushing over stone,
Gray mountain ridges capped with scalloped heights,
The robin's chortle and the dove's strange moan.
I love the world of blade, bank, bush, and vine,
And love it best with knowledge it is Thine.

alf across Africa. I wanted to see a new ountry. . . ."

And that night, within the heroism of he World War II exploit, which both introduces and concludes *Rumble of a Distant Drum,* there occurs the recollection of all that happened on that long-ast safari. For the author, for the reader, t is recollection within recollection, and t is a dream not only of stirring events ut of an influence that fortunately may till be felt by a civilized world that has oo little sophistication in its appraisal of rimitive virtues. It is a dream, too, to tir the nostalgia of all remembrances of ge ten.

"With the faint rumble of a distant lrum still throbbing dimly in his ears, ie dreams throughout the short and ilent hours before the dawn. Dreams gain of that first journey across these ery mountains, far beyond the hinter-and, when he, Mihigo, The Hunter, a ittle boy of ten, had left the safety of is father's hut and had gone forth, trong in faith and courage, to meet his reat adventure."

The dictionary defines an epic as "a ind of narrative poetry in which is reated a theme of action in heroic pro-ortions and style," but it also applies he word to "an epiclike composition," nd perhaps one is not far from wrong n thinking of *Rumble of a Distant Drum* s epic in this sense. Aristotle required f an epic a dignified theme, organic nity, and an orderly progress of the ac-ion. *Rumble of a Distant Drum* has all hese. And it tells its diversified, enriched ale in terms of a single hero, recreates he life of a people, and reads aloud like rose that might have been translated rom some great poet of a foreign tongue. One can hardly help suspecting that Mrs. Akeley, with her poignant recollections f two decades and with what she calls scrupulous toil in the faithful portrayal," as created a work that will endure.

It is indeed destined for at least one ttempt at modern family reading. And he prospects for its success are all the etter because of Arthur August Jans-on's illustrations, for these drawings, ike the book, are not only artistically atisfying; they are as vivid as the draw-ngs of the South Sea natives who threat-ned John G. Paton. In fact, they are as ivid as the *recollection* of those South ea scenes. And that *is* vivid.

Rumble of a Distant Drum: A True tory of the African Hinterland. By Mary . Jobe Akeley. New York: Dodd, Mead Company. 1946. 364 pp., with map, and 8 drawings and end-papers by Arthur ugust Jansson, artist of the Akeley Afri-an Hall Expedition for American Mu-eum of Natural History. $2.75.

Gardens Indoors

The Picture Primer of Indoor Gardening. By Margaret O. Goldsmith. Boston. 1946. Houghton Mifflin Company. 48 pages. Illustrated in color by Harrie Wood. $2.00.

Growing plants successfully indoors is an activity that seems difficult for many and easy for others. Those who have failed undoubtedly have not given the requirements of plants indoors the study they deserve. There is a science to such cultivation; not a ponderous and difficult science, to be sure, but one that must be considered if success is to be obtained. Within the pages of this most attractive and colorful little book will be found the key to indoor plant culture.

Seabee Naturalist

Ready on the Right. By Ralph J. Donahue. Kansas City, Missouri. 1946. Smith Printing Company. 194 pages. Illustrated. $3.00.

Readers of this magazine may recognize the name of the author of this book as a contributor to our pages. A veteran of two wars, he took part in World War II as a Seabee, his travels including several Aleutian islands, Hawaii, Eniwetok, Guam, Ulithi and Okinawa. Whenever he had the opportunity he was off on some study of the natural history of the spot to which fate and war carried him, or was collecting specimens to send back to Stateside museums. Thus a great deal of Nature information about the spots visited finds its way into this book. The travel story of the Seabee-naturalist is, to be sure, primarily of interest to those who were in this branch of the services, but it is entertaining as well to the average reader, both for the Nature material and as a record of the war work of an outstanding unit.

About Woodcock

Woodcock Ways. By Henry Marion Hall. New York. 1946. Oxford University Press. Illustrations by Ralph Ray. 84 pages. $6.50.

This book is mainly a reprint of articles about the woodcock that have appeared in sportsmen's magazines. It is the stated aim of the author "to tell what I can about its ways, both nocturnal and diurnal, but not to limit details to those which become obvious during the brief two weeks of the shooting season." Nevertheless, of the 82 pages of actual text, upward of 60 have to do largely with gunning, although here, and elsewhere, the life history is covered, and even solemn warnings of the necessity of short seasons, and the voluntary limiting of the power to destroy, are urged. All in all, the book, which is published as a memorial to an only son recently deceased, is one of the best accounts of this remarkable and well-loved species. The drawings, with one or two exceptions, are well chosen, and all are beautifully executed.

E. A. P.

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New Darwiniana

Charles Darwin and the Voyage of the eagle. Edited by Lady Nora Barlow. ew York. 1946. The Philosophical Li- ary. 279 pages. Illustrated. $3.75.

Darwin described his trip on the *Beagle* "by far the most important event of y life." During the famous five-year ip, he wrote thirty-six letters to his mily. Excerpts from these have been ublished before, but they have never een brought out in their entirety, which the purpose of this immediate volume. s a whole, these letters provide a more timate and complete record of the emo- onal and intellectual reactions and owth of Darwin. In preparing to gather em together, Lady Barlow, Darwin's anddaughter and student of her illus- ious grandfather's life, has scanned the nall notebooks in which were recorded e *Beagle* experiences for further sig- ificant material. The result is an im- ortant contribution to Darwiniana.

Seton Reprint

Wild Animals I Have Known. By rnest Thompson Seton. New York, 1946. amtam Books. 179 pages. Illustrated. 25 nts.

This book, in its original and subse- uent editions, has long been a classic the field of animal literature. It is ow available in pocket form as one of e Bantam books.

For Chemists

The Chemical Senses. By R. W. Mon- rieff. New York. 1946. John Wiley and ons. 424 pages. $4.50.

Taste and smell are the chemical enses, and as such are fascinating and elu- ve. In this book the author delves into e operation of these senses, writing for e chemist, or for the individual with a emical background.

Park Visitors

All records for attendance in National arks were broken during the 1946 travel ear, with a total visitor figure of 21,682,- 32. This was an increase of 632,356 over e previous high record of 1941. The reatest attendance was registered at reat Smoky Mountains National Park ith 1,147,377, and Yellowstone, the old- t member of the park system, recorded 4,907.

Sewage as Fertilizer

Of particular interest to those working the field of control of stream pollution a manual of the Federation of Sewage orks Associations entitled "Utilization Sewage Sludge as Fertilizer." This ap- ars to open many possibilities for find- g an economic value in sewage, and us greatly justifying the cost of treat- ent plants, with consequent diminution stream polluion.

Wildflower Photography

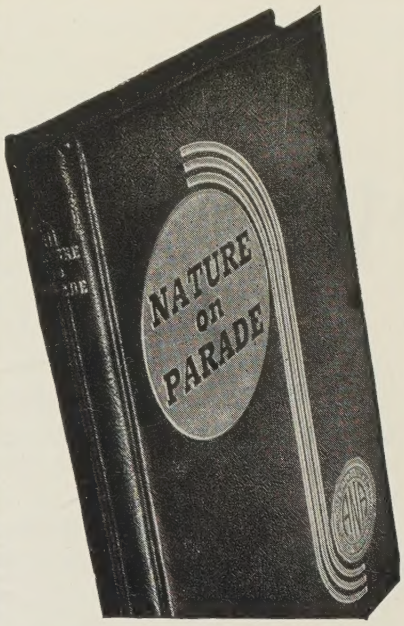
The southeastern chapter of the Michigan Association for Native Plant Protection announces the First Michigan Annual Salon of Native Wildflower Photography to be held from March 15 to March 23. The exhibition will be at the Michigan Flower and Garden Exhibition of the Michigan Horticultural Society in Detroit. The deadline for receiving prints for entry will be February 15. We wish that we might have been able to pass this information on to our readers earlier, but the exigencies of magazine production are such that many such announcements come to us later than they should. However, information can be obtained from Roger E. Richard, P. O. Box 281, W. Dearborn, Michigan.

Barn Swallow Nesting

For at least fifteen years barn swallows have nested in their barn, writes Miss Berta Bennison of Lenox, Iowa. Two broods were raised each year, usually in two nests so placed that the farm cats could not climb to them. Last year, however, baled hay would have put the nest within reach of the cats, so the swallows selected another site in a safe spot. Five young were raised and gotten on the wing, whereupon the birds cleaned out the nest, relining it with mud and feathers. The day that it was finished some children knocked the nest down with a pitchfork, leaving the birds disconsolate and silent all that day and into the next. So Miss Bennison got a half-pint ice cream container, daubed mud on the outside, and a little on the inside to hold feathers, and placed this improvised nest where the other had been. Within ten minutes the swallows took over, singing happily again. Four eggs were laid and hatched, the young raised, all finally departing.

Washington Hawks

Finding a woeful ignorance on the part of the Washington State Game Commission, so far as hawks are concerned, the Seattle Audubon Society has set out to do something about it. Investigation revealed that the State authorities not only made no distinction between good hawks and so-called bad hawks in their predator control work, but were violating their own State laws, which protect certain species. Study revealed that an effective campaign of official and public education is needed in this northwestern State. To that end an excellent leaflet entitled "The Truth about Washington Hawks" has been prepared by Ellsworth D. Lumley, president of the Seattle Audubon Society, and copies are available from him for all who wish to help. The address is 6224 25th N.E., Seattle 5, Washington.



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BELL TELEPHONE SYSTEM

Contents Noted

WE HAVE lost a reader of *Nature Magazine* in Michigan; apparently a reader who traces his ancestry to the very first inhabitants of what is now the Wolverine State. He writes, and we quote exactly: "there is no nature in Mich it is all dead the men kiled all my nature food and wasted it so I cannot use the magazine no more. Pale face Bad to nature." We have not been in Michigan recently and can hardly believe that things are as bad as this note indicates. However, we hope that the Michigan Conservation Department will get busy so we will not lose more Michigan readers.

ANOTHER reader, Neal Wilson of Cuba, New York, reports an interesting incident of the wild. He and a companion were following a well-beaten path in a wild section of northern Pennsylvania when a wild rabbit hopped out into the path about fifty feet ahead. Mr. Wilson stopped and the rabbit came quickly to him. Remarking that the animal must be blind, Mr. Wilson stooped to pick it up, but the rabbit hopped quickly away and disappeared into the brush. At that moment a bobcat emerged at the spot where the rabbit had come into the path. The cat took in the situation, whirled and was off. Apparently the rabbit had thought quickly, and, choosing the men as the lesser of two evils, sought safety with them. Or perhaps it knew, by some strange telepathy, that Mr. Wilson was a friend, for he says that he is not a hunter because "several years ago I wounded an animal, which forever ended my hunting and left me with a very fine collection of useless guns."

THIS seems to be readers' month on this page, so we will pass on another bit of Nature correspondence from a reader, Celia Ruth Fisher of Wellsburg, West Virginia. She was washing dishes when a moth lit among the suds. Clearing a patch of the dish water, Mrs. Fisher found the insect swimming bravely. Fishing it out, she placed it on a tray, calling to her husband to inquire how one administers artificial respiration to a moth. He was no help, so she did her best to aid the insect to dry off and unstick its wings. Finally, dry, the insect tried flight, succeeded and settled down for the night in the fold of a curtain. "I was so pleased at his recovery," writes Mrs. Fisher. "I have always wanted to rescue someone." Somehow we got a special lift from this letter. Compassion for a moth may seem like super-sentimentality to some, but, to us, perhaps the greatest Biblical lesson lies in the words "and the greatest of these is charity."

IN OUR October issue, writing on pollen, Donald Culross Peattie says that "by pollinating a rose that has a factor for ever-blooming, but no gene for fragrance, with a rose that has a gene for fragrance but none for ever-blooming, today's breeder hopes to get a rose that will be both fragrant and ever-blooming." Whereupon E. F. Mallett of Windham, Ohio, reports possession of such a rose; has had it for twenty-eight years. Dozens of plants have been raised from slips, all coming true to form. The roses bloom from early spring to late fall, and a potted one in the house bloomed all winter. A half-dozen buds will scent a whole room. Thus, it would appear, Nature has been playing around with the genes and produced the desired rose all by herself.

A READER sends us a clipping from the *Chicago Tribune* reporting an outdoor fatality. A father and son from nearby Gary set out to check their game traps. The son went ahead of his father and came upon a trap holding a large raccoon. The young man "swung at its head with the butt of his shotgun. The blow struck and stunned the animal but it also discharged one barrel of the gun." The charge struck the young man in thigh and groin. Hearing the shot, the father ran to the scene, finding his son lying on the ground, "the raccoon twisting in the trap." The father "seized the shotgun and struck the animal again. The blow killed the raccoon but discharged the second barrel of the gun." The shot struck the father in the abdomen. Crawling to the highway, the father hailed a passing motorist and both wounded men were taken to a hospital. The son died; the father had an even chance to live. The reader who sent this clipping observed: "This might be called retributive justice."

We lost a splendid American when Walter Johnson, probably the greatest of baseball pitchers, passed away. Once Walter was inveigled into a deer hunt. Afterwards he said: "When I saw the eyes of the dying animal I had shot I knew I never would go deer hunting again."

R. W. W.

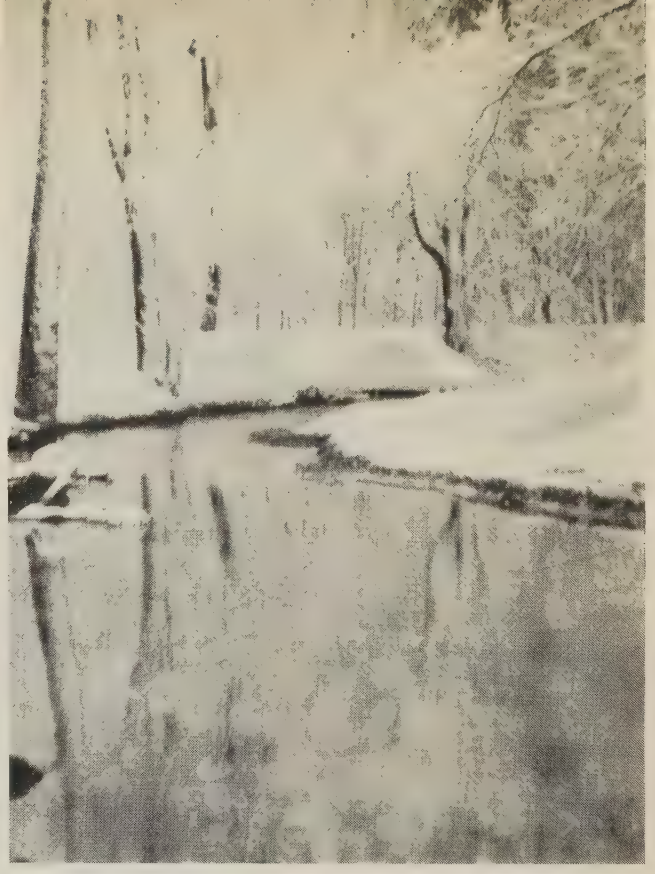
PHOTOGRAPH BY N. E. NILSSON

Carefully restored, externally and internally, the cabins in New Salem State Park, near Petersburg, Illinois, recreate the village of New Salem as Abraham Lincoln knew it during the brief period of its existence.

Lincoln's Woods

By VIRGINIA S. EIFERT

Photographs by the Author



THEY were not really Lincoln's woods—not his by right of deed and ownership—but his because he lived in a clearing above the woods, nd knew them from hill to hill and from valley to alley. They lay all about the short-lived pioneer ttlement of New Salem, Illinois, which was built in 330 above the winding Sangamon River. And these oods—Abraham Lincoln's woods—today are little anged around the restored village.

When Abraham Lincoln's destiny brought him to ew Salem, he walked these woodland trails. He new the hill woods in spring when the wild blue nlox was blooming; knew the white-armed sycaores along the river when sumer was at its peak and the voices the redstarts were everywhere; new the blaze of sugar maples nd the flutter of lilac asters when utumn visited the land; knew the coad, snowy space of winter when e river was frozen and wolves owled on the prairie hills at ght. Lincoln knew all of these.

Spring along the Sangamon brings robin snows that crust the trees with crystal, melting by noon in the morning sun. Such late snows Lincoln knew at New Salem, where has been recreated the settlement of his younger days, including the schoolhouse, as seen from the path that led from the stream.

Today the winter's landscape easily takes one back to a biting February day in the 1830's—a grim, cold, stark, gray day with a lowering sky, which, if all the signs told truly, would let down snow before another day was past. The great silence of the Illinois winter was all about—a voiceless silence; bare trees still and aloof; a marsh hawk, gray as a gull, swooping, dipping, sailing, quartering off the bottomlands.

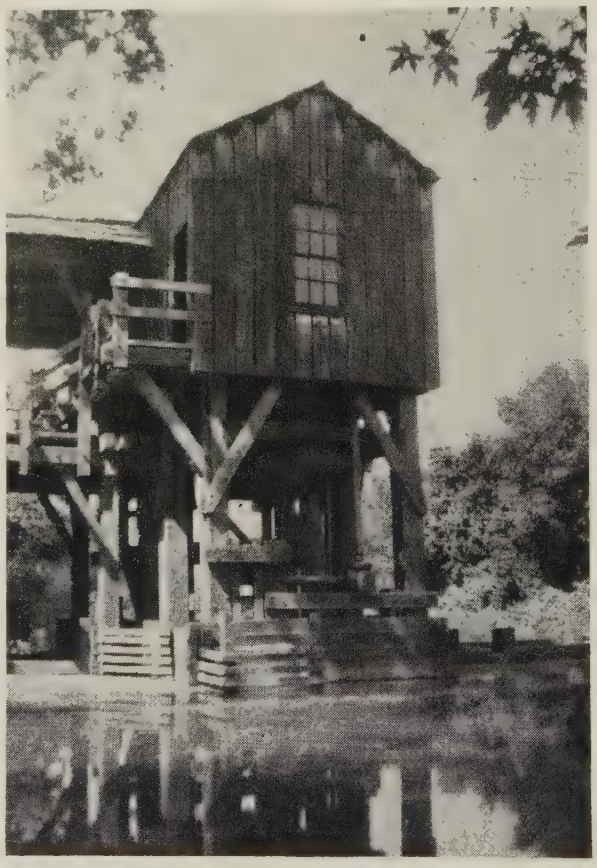
It is a timeless scene—winter, the river, the hawk. On such a day, with his shabby coat flapping and his head tied in a shawl, young Abe Lincoln might have walked the path down the New Salem hill to the rutted road to Springfield, twenty miles across the windy prairie. In sheltered hollows in the woods were titmice and chickadees that flitted and talked among the oaks; cardinals flashed carmine as they flew across the frozen creek. Crows jeered from the oak-tips; bob-whites flew up with a whir of wings from the prairie weeds as the man strode past.

It may have been past sundown the next day before he returned to the village on the hill. The early winter dusk drew a thin line of lemon color behind the trees to the west, and the great horned owls were calling hungrily from the woods. That night a light snow fell to cover the old, and next morning there were wolf tracks alarmingly close to the cabins and sheep pens on the hill.

New Salem in the prairie wilderness came into existence shortly after the Rutledge-Cameron grist mill began operation on the Sangamon. People from scat-

tered cabins located many miles away on the buffalo trails and rutted wagon tracks that marked the prairie came to the new mill to have their corn ground into meal, some from so far away that they needed a place in which to spend the night before starting back. There was no place to stay, and nothing to do but camp in the woods, until enterprising James Rutledge from Kentucky, one of the mill-owners, felled a few oaks on the hilltop above the mill and built a log tavern in the scanty clearing. Houses followed, log houses set along a rambling path that bisected the hilltop from east to west. Gradually the trees fell back until the clearing was almost bare, except for stumps that stood everywhere and were a menace to any man who walked there in the dark. But the trees — the white and red oaks, the honey locusts, the sugar maples, the white ashes— gathered closely on all sides of the village, as if waiting to come back to the spot from which they had been ousted.

In the hollow to the south there was a pleasant, tumbling stream, which, unlike the muddy streams of middle Illinois, was rocky and clear, and there were silvery minnows in it. Among the oaks on the hill above this stream was Mentor Graham's austere log schoolhouse, with its small cramped windows that let in scarcely any sunlight. Inside were hard benches, a fireplace, and the schoolmaster's desk.



The Rutledge-Cameron grist mill once more is ready to grind corn. It is part of the restored village of New Salem in central Illinois.

All around the school, and in the woods along the schoolchildren's path, there were fox squirrels, chipmunks, cottontails, bluejays, woodpeckers, and towhees—creatures that, to Lincoln, were well loved and familiar. Ever since his boyhood in Kentucky, the wildlings and the trees had been his friends. In the New Salem woods they offered a companionship that must have been welcome to the man who, all his life, was a lonely person.

It is probable that he knew few of the birds by name. Few folks did in those days. There were no bird books in the village, nothing for a man to use if he had the unusual wish to know the name of a bird that whistled at him on a winter's morning. Alexander Wilson's tome had not yet penetrated the Illinois wilderness; Audubon's bird paintings, which were startling London, would have been far too costly a luxury for this plain, pioneering community. There was nothing to encourage anyone to identify birds, even if he had wished to do so.

Some men, however, knew the trees because that knowledge was considered practical. One had to know a sassafras tree in order to dig the orange roots for tea to "thin the blood" in spring; to know the red-haws and wild crabs because the housewives made preserves and jellies from the fruits; one had to know the difference between an elm and a maple when cutting wood, because elm wood shot sparks from the fireplace and maple did not. Abraham Lincoln knew his trees. According to the comment of his son, many years later in Washington, the sugar maple, perhaps first learned in the New Salem woods, was Lincoln's favorite.

After a few years, Lincoln left New Salem and went to Springfield to practice law. In 1839 New Salem died. Less than a decade after it had begun, with great hope of becoming a town, the settlement disintegrated into the prairie soil. It was as if the spirit of this man, who stayed here a little while and then went on to carry out his destiny, was all that held the village together. The people scattered to nearby communities that were more easily accessible than hill-top New Salem. The site grew up in weeds and the woods were known only to creatures that lived there; to foxes, owls, and whip-poor-wills.

Many years later there were attempts to restore this historic spot, but the results were crude and unconvincing until the Illinois Department of Public Works and Buildings, with the assistance of the National Park Service and the Civilian Conservation Corps, worked with care and deep thought to produce a restoration of the village. Under their skillful hands, New Salem lives again. Here not only are the authentically built log houses on their exact sites, but each is completely furnished with original materials owned by descendants of the New Salem people. The blacksmith's shop is dusty and littered with iron shavings; the carding mill, with its elaborate carding machine brought from the East, is the most imposing building in the village; the cooper's shop has its half-finished barrels standing about; the big iron kettle that was part of the working equipment of Martin Waddell, the hat-

ter, stands in the shade of a climbing river-rose that scrambles over a lean-to porch. The homes of Dr. Regnier and Dr. Allen, the two doctors who practiced in the village, are outfitted with the bottles and tools and nostrums popular in those days, and the splint-fenced gardens back of these cabins contain the aromatic herbs that provided medicines for the people of the community—horehound, catnip, fennel, dill, digitalis, cimicifuga, sage. Garden patches are planted each springtime with seeds of the sort that were grown here more than a hundred years ago, usually cabbage and beans, turnips and corn, with often a patch of tobacco, a bit of cotton, some hemp, and broom corn, because most of the New Salem people came from Kentucky and were accustomed to these things. Chickens walk about in the grass and lay their eggs in the barns; barn swallows build their mud nests in the lofts, and wrens nest in gourds that were grown in the village. A postmaster takes in and sends out mail from the restored post office where Lincoln once clerked. The general stores are stocked with bolts of calico; with glass jars of rock candy and striped peppermints; with churns and brooms and boots.

Stumps have been brought in and planted to give an illusion of a recent clearing. Down beside the river, where the prothonotary warblers in summer flash their orange-peel brilliance, and where, along the mill-pond at dawn, a great blue heron stalks his prey, the Rutledge-Cameron grist mill once more is ready to grind corn. Truly, New Salem seems again to live.

At the restored village wrens still nest in gourds, which are grown in the local gardens, and dried and hung for the benefit of the bird inhabitants.

All these things are very good. In its sincerity, authenticity, and workmanship, the restoration of New Salem is comparable to that of Williamsburg. But the village obviously is only a restoration. It is not actually the real thing.

But the woods are real. They are still Abraham Lincoln's woods, and his presence lingers there. Some of the original trees still stand, for some of the huge white oaks compare in size with stumps in the neighborhood that measure more than two hundred rings. Lincoln's woods still lie on either side of the village and hem the winding Sangamon. It is they, more than the faithful restoration of a pioneer settlement, that preserve and make real the story of a prairie man.

There, south of the village, are footpaths that very likely follow the original trails made long ago by deer and wolves, by Indians and pioneers. One of the paths leads down the hill from the back of the village to the rocky stream that still makes a pleasant noise over its stones. There still are fox tracks along the soft, muddy banks where doubtless there always have been tracks of hunting foxes.

Springtime comes to these New Salem woods as it comes all about to middle Illinois, as it came more than a hundred years ago to Lincoln's woods. Spring in this country is a hesitant stepping forward out of snow and cold, perhaps only enough to liberate a mourning cloak butterfly that wintered behind a shred of hickory bark. It may include a sudden stepping back to freezing temperatures, which, nonetheless, do not wholly discourage the early bluebirds along the river, or harm the burst of polleny blossoms on the soft maples.

There may be set-backs and periods of unseasonable warmth; there may be rains and robin snows, but spring in Illinois is on its way. By late February and early March there are signs of new life all along the trail from the village to the schoolhouse —catkins on the hazel bushes, a phoebe along the creek, ruby spore-capsules on the emerald banks of Catherinea moss. Suddenly there are the first spring beauties, which each year come somehow as a total surprise. Scarlet cups hide their color among the damp old oak leaves; towhees and fox sparrows, singing, join the cardinals, titmice, and bluejays that stayed in sheltered places all winter. And on a bright spring day the jays, in the exuberance of their springtime mood, stir up the great horned owl that sleeps all day in a red oak back of the schoolhouse.

One day the first myrtle warblers are back. Morel mushrooms leap up in the rich woods soil; the fox tracks are more abundant than ever along the creek where the toads trill at night; and the woods are full of the lavender bloom of wild blue phlox, the delicate flutter of cleft phlox near the old quarry, the maroon of red trilliums, the unfolding bronzy umbrellas of the mayapples. New leaves are on the oaks, and redbuds are in bloom. A water thrush, teetering

on a wet log beside the stream, sings an ecstatic burst of song; the cardinals busily gather long shreds of grapevine bark to line their nests.

One day the Kentucky warbler, a glittering morsel of bright gold, green-brown, and black, peers from the Virginia creeper vines near the school, sings a ventriloquial song that belongs to these woods, and builds a neat nest among the bedstraw beside the path. From this leafy trail a whip-poor-will in moth-like flight springs up from its two mottled eggs laid on the oak leaves, and flutters away among the trees.

Everywhere in these woods the ghost of Lincoln's presence and his affection for wild things is all about. And it is no more vivid, perhaps, than at dusk on a summer evening when the calling of the whip-poor-wills is all about. These voices of the wild are everywhere—in the locusts on the hill, on cabin roofs, among the oaks, calling until the dusk is clamorous with their voices. The sound of the whip-poor-wills rises, falls, pulsates, fills Lincoln's woods with a wild, timeless sound that has no beginning and no ending, so long as these woods remain.

★

Night Work

By JOHN GALLINARI WHIDDING

Behold this silken seine
  Pegged wide and tight
To catch the little rain
  Of melting night

For bait in turn to snare
  Such morning-beams
As now lie captive there
  Like broken dreams . . . .

For this brief golden catch
  The spider sets
By dark in hedge and thatch
  His sturdy nets,

While on the worn cement
  The moonstruck snail
Parades with bold intent,
  In shining mail—

His purpose less obscure
  Than we may think
Who find his signature
  In silver ink!

★

Winged Colors

By PAUL CHURCHER

Man, in his brief and hectic history, has produced some remarkable daubers in paints and pigments. Yet none of them have ever approached Nature's casual achievements of living coloration. Birds alone are flashing proof of this, and the varied brilliance of their tones and hues of beauty is constantly reflected in the names that many of them bear.

Here, incorrectly matched in a double list, are the names of twenty well-known birds of North America, birds whose names contain references to twenty different shades or colors. Can you unscramble and rearrange them, correctly paired?

Count five for each and see how close you can come to a perfect score. See page 106 for answers to this avian quiz.

1. Bronzed	a. Blackbird
2. Snowy	b. Rail
3. Indigo	c. Junco
4. Golden	d. Flycatcher
5. Ruddy	e. Spoonbill
6. Sooty	f. Pelican
7. Rusty	g. Phalarope
8. Scarlet	h. Bunting
9. Brown	i. Warbler
10. Yellow	j. Duck
11. White	k. Finch
12. Blue	l. Tanager
13. Green	m. Teal
14. Roseate	n. Owl
15. Slate-colored	o. Jay
16. Purple	p. Creeper
17. Olive-sided	q. Plover
18. Cerulean	r. Grackle
19. Cinnamon	s. Heron
20. Red	t. Shearwater

See whether you can see the rufous-breasted castlebuilder at its nest. The doorway to the nest is the round opening in the center of the pile of finer sticks in front of the bird. This doorway leads through a narrow tunnel to the nest-chamber at the left. Here rest the eggs and nestlings, protected from rain by the coarse thatch piled high above the chamber.

The Castlebuilder

By ALEXANDER F. SKUTCH

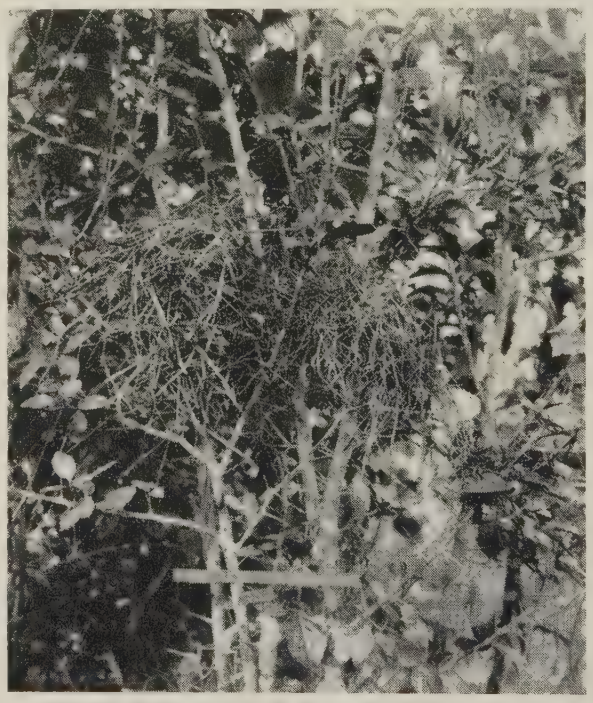
OVER much of South America there is found a stout, long-legged, bright-brown bird slightly smaller than the meadow-lark. With mud or wet clay it laboriously builds, on the top of a fence post, or in the stout crotch of a tree at no great height, a substantial nest with a domed top and a round doorway in the side—a miniature of the clay baking oven of tropical countries. Hence the industrious builder is called *El Hornero* or "The Ovenbird"—a name to which it has far better right than the ovenbird of North America, a warbler whose nest, although oven-like in form, is built of materials that would not resist a fire.

The South American ovenbird has given its name to a large and exceedingly varied family of birds, the Furnariidae, abundant throughout South and Central America. Although in temperate South America they form one of the principal elements of the avifauna, strangely enough, members of the ovenbird family hardly pass north of the Tropic of Cancer, and are quite unknown in the United States. No other family of birds in the Western Hemisphere constructs such varied nests, nor those so large in relation to the size of the builders. Most, however, are made of sticks and other vegetable materials rather than of clay. Those who have fallen under the spell of that delightful book, W. H. Hudson's *Birds of La Plata*, will be familiar with many of these birds and their architecture—treated, however, in the family Dendrocolaptidae, or Woodhewers, from which recent authorities have, with good reason, separated them.

One member of this engaging family that dwells farthest to the north is the rufous-breasted castlebuilder, *Synallaxis erythrothorax*, a bird the size of a small wood warbler. In the lowlands of southern Mexico, Guatemala and Honduras, one with ears attuned to such things often hears its frank, good-naturedly persistent *pet chu, pet pet pet pét chu* issuing from the depths of sóme low, second-growth thicket. But so dense and impenetrable by man is the vine-entangled vegetation amid which the author of these appealing notes lurks, that it may be long before the bird-watcher succeeds in catching a glimpse of the little, slate-colored bird with the ruddy breast and wing-coverts. Although retiring, the castlebuilder is not shy, and when foraging near the edge of the thicket will permit you to come near enough to note the finer details of its appearance—its sharp, wren-like, black bill, its red eye, the fine white streaks on its slate-colored throat, its pale-brown tail feathers frayed and worn by constant passage through dense vegetation. These tattered feathers have given the name spinetail to this bird, and to numerous relatives that live farther to the south; but they are not actually spinous-tipped like the tail feathers of woodpeckers and other climbing birds; and castlebuilder

seems to be a far more appropriate name for this bird.

In size, solidity of construction and complexity of form, the nest of the castlebuilder is to the nests of most other small birds as the towering castle of some medieval baron was to the surrounding huts and humble cottages of the common folk, his vassals. With the castlebuilders, building the nest appears to have become an obsession. Their great, elaborate castle of sticks occupies their unremitting attention during four or five months each year. Unlike nearly all other birds, they continue to add to it while incubating their eggs, and even while feeding their nestlings. So absorbed do they become in the work of building the nest that they continue to carry sticks to it while a person stands quietly in full view, hardly more than an arm's-length away. I have cut my way noisily through the bush-tangle in which they lived to within a yard of their nest without interrupting their building. While practically all other birds clearly build the nest merely as a receptacle for eggs and young, with the castlebuilders the construction of the nest appears to have become an end in itself.



A nest of the sooty castlebuilder in western Panama. This simpler nest lacks the entrance chimney and is entered directly through the end of the tunnel at the extreme right. The ruler below is one foot long.

In the humid Caribbean lowlands of Guatemala and Honduras, the castlebuilders lay the foundations of their huge edifices toward the end of March, or in early April. Their site is usually in a vine-draped bush or small tree, from six to twelve feet above the ground, but rarely as low as five, or as high as twenty feet. Their bulky structure requires the support of a stout, nearly horizontal limb with several lateral branches, or, better, of two or more branches that run parallel and close together.

Male and female castlebuilders, which are alike in plumage and size, work together in closest harmony at the task of nest-building. Until the nest is far advanced, their material consists almost wholly of coarse sticks, which they gather on or near the ground. Some of these are as much as sixteen or seventeen inches in length and nearly as thick as a lead pencil. The heavier ones weigh from two to four grams. Such sticks are no slight burden for little birds that measure only five and one-half inches from the tip of the bill to the end of the tail, and it costs them much hard work to raise these twigs through the entangled vegetation and place them in the growing nest. Sometimes the castlebuilder, attempting to fly up to its nest with a particularly heavy stick, grasped near the middle in its slender bill, is borne back to earth by the weight of its load; but it persists in its efforts until it gains a low branch in the tangle where the nest is situated. Then, by a series of short flights and hops from perch to perch, with much flitting of the wings to keep its balance, it gradually attains its goal, showing considerable skill in guiding its unwieldy burden between the close-set branches.

Arrived at the nest, the bird deposits its burden and industriously pushes and tugs until it fits securely in the desired position. Often, however, the stick is knocked from its bill by some unnoticed obstruction, or dropped because of sheer weight. Then the tireless little bird follows it to the ground, and undertakes anew the task of raising it by a circuitous route to the nest. Likewise, it descends to bring back sticks that fall from the nest while being arranged there. In this the castlebuilder differs from its relative the firewood-gatherer of Argentina, which, Hudson tells us, rarely tries to recover the material it has dropped on the way to its bulky nest, until at length enough fallen sticks to fill a barrow accumulate beneath the nest-tree.

The growing nest soon acquires the form of a bowl. At this stage it resembles, except for the absence of a lining, the structure that many a larger bird would find a satisfactory receptacle for its eggs and its babies. But the castlebuilders have hardly begun their ambitious undertaking. As they continue to build, they extend the rim of the bowl on the side by which they habitually approach, until it forms a gangway over which they now carry their sticks. Elsewhere the birds build up the wall, at the same time contracting it toward the center, until the bowl is completely arched over with sticks. Simultaneously, they add sides to the gangway, and then begin to cover it over at the point where it joins the body of the nest, forming a tunnel. The nest at this stage is an oven-shaped structure entered through a spout-like projection from the side. The castlebuilders have now devoted nearly two weeks to their task, and already have a nest far bigger and better enclosed than that of any migratory northern bird, including those up to several times their size; but still their work is only half done. The tunnel is only partially covered,

and must be provided with a roof out to the end.

To leave open the end of this tunnel, as does the sooty castlebuilder of southern Central America, would afford a method of entry into their stronghold far too direct for the rufous-breasted castlebuilders. As a further safeguard, like the winding entrance to some old Spanish fortress, they close off the end of the tunnel and build an entrance chimney above it. This consists of a circular pile, often a little tower, of twigs, which are usually thorny and are not only shorter but always much finer than those used elsewhere in the nest. Through the center of this pile the birds enter and leave their home. The entrance, and frequently the entire length of the tunnel, is surrounded by a broad platform of coarse sticks on which the castlebuilders can alight and walk around.

The nest-chamber, when first covered, has by no means a roof that will shed water, and the birds now devote much labor to supplying this deficiency. They fetch short, thick sticks, broad pieces of bark, weed stalks, dry petioles, and fragments of the leaf-bases of giant herbaceous plants—all material quite different from that which forms the body of the nest—and heap it above the chamber to form an efficient thatch that will shed the rain. This material may at length form a pile rising eight or ten inches above the ceiling of the nest-chamber.

Almost a month may elapse before the wonderful structure appears completed, but its exacting builders never consider it so, and continue to lavish their energies upon it until the eggs are laid, some five to seven weeks after the first sticks were placed. Even during incubation they continue to bring fresh material to it, increasing its bulk without essentially altering its form, until it becomes a monument to the tireless energy of the little builders, all out of proportion to their size. The final dimensions of the nest depend, among other things, on the length of time it has been in use and the nature of the site. If the supporting branches form too narrow a foundation, there comes a time when much material brought by the birds falls from the sides of the nest, which then fails to grow as bulky as it might have done if the birds had chosen a more ample support. Thus there is considerable variation in the size of different nests. A fairly typical structure found in Honduras measured twenty-nine inches in greatest length by nineteen inches in height at the large end, where the nest-chamber was situated. This chamber was between five and six inches in diameter, and the height from floor to ceiling four and three-fourths inches. Above the chamber the thatch was piled to a height of ten inches. The tunnel through which the chamber was

A castlebuilders' nest viewed from above. At the right is the little tower of finer twigs through which the birds enter. At the left is the coarse thatch that diverts water from the nest-chamber. In the photograph at the left is a nest of the rufous-breasted castlebuilder in a thicket in Honduras. The chamber that contains the eggs is on the left, the entrance on the right.

entered was fourteen inches long and one and one-half inches in inside diameter, and was surrounded by a platform eighteen inches in length by seventeen in width.

In May, the female lays four, or, less frequently, only three, delicate, roundish eggs, which may be either pure white, white with the faintest tinge of blue, or else a beautiful pale blue. The eggs in the same nest seem always to be of the same color, and sets of blue eggs are much less common than those of white eggs. When first laid they rest upon a few green leaves, hardly enough to prevent their touching the hard sticks of the chamber's floor. While incubation is in progress, fresh leaves are added daily, until at length the eggs repose upon an ample, soft lining, which becomes the bed of the nestlings.

As they shared the work of nest-building, so male and female divide the duty of incubation. They sit rather impatiently, rarely continuing on the eggs for more than three-quarters of an hour at a stretch. If the mate does not come to replace its partner after this interval, the latter may go off and leave the eggs unwarmed while it seeks food. But often the castlebuilder will return to relieve its mate after it has been incubating for only ten or fifteen minutes. Sometimes, without waiting to be relieved, the bird neglects the eggs in order to give attention to the nest itself.

It requires constant attention to keep in good repair a household so large and complex as that of the spinetails, and they do not stint the time they devote to it. To preserve the nest in shipshape condition they lavish a degree of care that suggests loving pride and is pleasant to behold. Before entering or after leaving the tunnel, they usually find time for a round of inspection, and almost always notice something that requires adjustment. A broad piece of bark has fallen from the roof to the entrance platform, and must be replaced in the thatch where it belongs; then sticks that are slipping down must be moved up into a secure position. Fresh leaves must be brought into the nest daily, and added to the bed beneath the eggs. For this purpose they always select soft, downy leaves, particularly those of a species of *Solanum* common in their haunts.

Not only do the castlebuilders find time for these routine matters of maintenance, but much besides for adding to their nest and even for providing it with luxuries. As with many a human couple who begin life together with only the resources provided by their own labor, they start housekeeping with a minimum of comfort, and through frugality and industry gradually acquire the luxuries they desire at the same time as they bring up their family. It has already been mentioned that they constantly bring additional sticks to the nest both during the course of incubation and to a lesser degree while they attend the nestlings. But it is their unending search for the cast skins of snakes and lizards that occupies most of the time left free by the necessity to incubate the eggs and to find food. They seem never to have enough of this valued material; and the bird flying up to take its turn at incubation, if it does not bring a stick or a green leaf, will very probably bear a fragment of reptile skin in its bill. This it may either stuff into a crevice on the outside of the nest or take inside. Some is carried to the nest-chamber, but most is employed to cover the bottom of the tunnel. One pair, whose nest I pulled apart after they had finished with it, had completely carpeted their front hall in this manner, from the doorway right up to the nursery.

The castlebuilders seem never satisfied to allow these precious skins to rest long in one place. They frequently shift them from one position to another on the outside of the nest, or carry a piece from the exterior to the interior, or bring out a fragment that has hitherto reposed inside. When its spell of incubation is done, a castlebuilder often emerges from the entrance chimney with a bit of skin in its bill, and deposits it somewhere on the outside before flying off to feed. This habit of bringing the exuviae of reptiles to the nest is shared by the sooty castlebuilder, the crested flycatcher and related species that breed in holes in trees, by a number of wrens that nest in cavities and crevices, and numerous other kinds of birds. But few, I imagine, search for this material with the same zeal as the rufous-breasted castlebuilders. Although the member of the pair who happens not to be incubating is chiefly concerned with the care of the nest and the search for reptile skins, frequently the birds will leave the eggs unwarmed for many minutes together while they indulge in these absorbing occupations.

The castlebuilders are among the very few birds that consistently and apparently intelligently repair a specific injury to their nest. The only way I could learn exactly what a nest contained was to separate the sticks at the back or side of the nest-chamber and peep or feel inside. In order to follow the course of incubation and the develop- (Continued on page 106)

Rain-Window

By DANIEL SMYTHE

Here is a square of glass, washed over and over
By rain from the sky: I can see it clearly limned
With water; through a wavering line I can discover
Grass on the hillsides, and the tree strong-limbed.

Here is a moving picture that the eye may gather—
Shivering rain in the air, an earth that catches it all.
Strange that I stand here, seeing a stormy weather
Squared and held close by this opening in a wall.

Four fields beyond it, a hill, and threads of fences—
A glass between, and the lashed drops guided back.
But I can follow a cloud where the rain advances
Beyond the square of a sill, to a hidden track.

Thirteen species of the Australian grass tree grow within the Commonwealth. They belong to the genus *Xanthorrhoea* and have been found to possess a variety of interesting commercial possibilities, all of which have not yet been fully explored.

The Australian Grass Tree

By CHARLES LYNCH and PETER MORISON

PHENOLIC substances, as well as resins, balsams, sugary materials and paper pulp, are some of the varied products of the Australian grass tree, native shrub that has been found to possess many ossibilities in the development of chemical industry.

The grass tree, or, to use its botanical name, *anthorrhoea*, is a member of the lily family, and e genus, which includes thirteen species, is limited Australia. In some districts, under local names ch as grass trees, yaccas, yackers or blackboys, the ecies form a conspicuous feature of the landscape. hey are long-lived perennials with thick, woody unks that are between six and eight feet in height. ne trunks terminate in a rosette of narrow linear aves three feet or more in length. From this grows upright stalk topped by a spike of whitish flowers, casionally making a total height of twelve to fifteen c

Uprooted, the grass tree reveals its fibrous roots, ich reach only a few inches into the soil. The ible part of the trunk is made up of the old leaf s, which combine to shape the trunk. A thick, k, acaroid resin near the core of these leaf stumps binds them into clumps, which can be easily chopped away from the rest of the plant. It is possible to strip the leaf clumps and resin from the tree without killing it, as the inside core remains alive, still connecting the roots to the growing leaves. This core, when properly seasoned, can be turned on a lathe or worked up into ornamental pieces showing a beautiful and intricate grain.

When the leaves die they hang down in a thick cluster that provides dry kindling for fires, even during a heavy rainstorm. A few more years and they break off altogether, leaving only the broad leaf base adhering to its predecessors.

Most varieties of the grass tree seldom have more than one flower stem, but the *Kingia australis*, found in Western Australia, has been known to have several. Flowering is irregular but usually takes place after a forest or bush-fire. The flowers are numerous, sessile, closely packed and have numerous bracteoles surrounding each flower with a small or subulate subtending bract.

The trees are widely distributed throughout the Commonwealth, growing in all States and under

widely different climatic conditions. They are found in the desert regions of Western and South Australia, in the tropical State of Queensland, and in the cooler island State of Tasmania.

Most of the Australian grass tree gum industry is, however, confined to Kangaroo Island, a small island off the coast of South Australia, where the species *Xanthorrhoea tateana* is commercially exploited.

Most of the work on developing products from the tree has been concerned with the use of the resin. In this respect, the possibilities of the tree have already been practically demonstrated. Grass tree resin does not possess the character of a gum resin, but has been classified as a true resin, being insoluble in water but soluble in alcohol. During the war, it was used in munitions work, in pyrotechnical compositions, as a high melting point lacquer, and as a varnish for metals. In New South Wales, quantities have been used for the manufacture of proprietary stone polishes and floor stains. Red and yellow resins have been mixed with shellac and incorporated with turpentine and chalk to form sealing wax.

Picric acid may be produced from the resin by oxidizing it with nitric acid. Picric acid is used extensively in the manufacture of explosives, and also as a yellow dye for silk and wool.

Generally, work on the chemistry of the resin has shown it to be a very complicated substance, and much research yet remains to be carried out. Recent estimates stated that there were more than 150,000 tons of resin from grass trees available in South Australia, and that by suitable conservation a perpetual supply, sustained, could be assured.

In collection, the leaf bases of the resin are separated from the core by breaking them with an axe, and the resin is then sieved from the leaf debris. The method in use at Kangaroo Island, and in centers in South Australia where the industry is most strongly established, is to exercise great care in cutting the tree, so that the axe goes right to the core. By this means the leaf bases are cemented together in larger cakes by the resin, which lies near the core. A "jigger" separates the gum into two grades, rejecting most of the leaf bases, and also any large lumps of bases that are caked together by gum. Any bases left remaining with coarse gum are separated by winnowing.

In cases where the leaves have not been removed from the top of the tree, the shrubs are little affected by the removal of the gum. In many cases trees have yielded the resin twice, and even three times, at intervals of several years. In order to minimize resin loss during collection a steaming process has been devised. Mixed gum and fiber are placed in a vat heated with steam, after which the gum melts, is run into trays, and is then directed into receptacles to cool. This process usually reclaims about a third more than the "jigger" extraction method, but the tree is destroyed when it is used.

The popular name of blackboy is often given to these old grass trees because at a distance they resemble a native in his ceremonial dress.

In addition to its resinous products, the grass tree core has been found to contain a considerable amount of sugar similar to maple sugar. It has the unusual quality of fermenting without the agency of any substance other than those present in the tree itself. Another product of the shrub is an excellent cattle fodder, and it also has possibilities for use in the production of commercial alcohol. Experiments on paper-making from the core have also yielded promising results.

Destructive distillation of the whole tree has been proposed, and it is claimed that more valuable commercial products can be obtained from "blackboy" than from distillation of any other wood.

Despite its economic significance, however, the grass tree, or "blackboy", so called because of its resemblance at a distance to a native in ceremonial headdress preparing for a corroboree, will always recall, to Australians, the picnic fire with a boiling "billy", or tea bucket, and the fragrance from the rising smoke. This strange tree is a notable member of the distinctive faunal and floral families of the land "down under."

There's Tradition in the Pine Gum

By GLADYN CONDOR

Photographs courtesy of American Turpentine Farmers Association

Gathering the pine gum that has collected in the gutters attached to the trees. It will be taken to a central point for processing.

IN NO two sections or parts of our globe are mankind and his products identical. Each region has its own crops, customs, colloquialisms and commerce. An interesting example of a unique old industry of local character is the production of "naval stores" in the South. In the days of the wooden ship, pitch and tar were important. They were made from crude oleoresin from the living southern yellow pine. Oakum, mainly the coarser fibers of hemp, and mixed with tar, was used to calk the seams of the wooden vessels, and, unmixed, even in braiding the hair of the jolly tack-tars.

Today the wooden ship has become a structure of steel, and the production of the raw material of pine oleoresin has grown into one of the more important American industries, serving many purposes. Yet, clinging to the traditional name of olden days, the products of this industry are still known as "naval stores," although the connection with the Navy is now insignificant.

Intrigued, I asked a leading South Georgia landowner: "If naval stores are *not* stores of the Navy, what are they?" His answer was prompt: "Turpentine and rosin." This still left me mystified and curious, and I eagerly accepted an invitation to see "chipping" the next morning, although without the least idea what "chipping" was.

Next morning found me among the trees—more and bigger trees than I had ever seen. My awe at the height of some of the yellow pines amused my host. I asked, in all my ignorance, "How old are they?"

"See that little fellow over there," he replied. "He's nine and a half inches in diameter, and about forty feet high, and around fifteen years old. Now figure out the age of some of the others." It did not take a mathematician to decide that many of the trees were venerable, yet still hale and hearty.

The long pine needles—or leaves—are from 10 to 16 inches long, usually in bundles of 3's, and the cones range from 6 to 10 inches. While there are several species of pine growing in the South, the one considered best for naval stores is the long-leaf pine, *Pinus palustris*.

As you look at the countless, gray-barked trunks extending all around you, it seems as if a mist or fog enwraps them. I tried to picture a belt of these trees covering 50,000,000 acres of forest land and extending, mainly near the coast, through North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and eastern Texas to the Gulf. This, my guide told me, supports the vast American enterprise involved in the production of naval stores. Later I found out, statistically, that out of these 50,000,000 acres of forest land, 30,000,000 are now in production, supporting nearly 400,000 workers.

On each of the trees around me was a white streak.

"Cat faces" in the pine woods show the way in which the trees are cut to start the pine gum oozing. Note the gutters in place.

V-shaped at the top and extending down the trunk to a pan.

"What are these white places?" I asked a colored worker.

"Them's cat faces, Ma'am," he replied.

I was not too sure whether he was trying to be funny, but there was something about the marks that resembled a cat's face. The Negro, whose name was Charlie, invited me to watch him begin work on a tree, the little one that had been pointed out to me. Armed with a hook-shaped cutting tool with a U-shaped blade, Charlie made a deep cut through the inner bark of the tree.

"We-all calls this here knife a hack, Ma'am," he said, "and we does the chippin' with it."

The tree is chipped in the shape of a letter "V," in what is commonly known as a "streak." This chipping starts near the base of the tree—four and one-half feet from the ground—allowing for more streaks to be made at the upper end of the streak. A series of these streaks composes a "face."

"How often do you cut a streak?" I asked.

"We keep doin' this about once a week," he replied. "Usually we makes about thirty-two of them streaks on each face a season."

My guide caught up with me and explained that clean cuts through the bark allow the clear oleoresin to flow from the resin ducts that have been severed. It is believed that such wounding actually stimulates oleoresin production by the tree.

The oleoresin, or gum,—known to the trade as "dip"—flows over the face to one or two pieces of sheet metal called an apron or gutter, so shaped and placed as to guide the gum into the container or cut at the bottom. This cup is in itself rather interesting. In many cases it looks like a flower pot, without the hole at the bottom, although the majority of containers are made like long, narrow pans. These receptacles are made of clay, galvanized iron, aluminum, or even glass, although the latter is too fragile to be practicable.

Ten thousand faces are considered a working unit in the industry. It seemed to me that, if a new streak is made each week, the cups would quickly be full. Actually the cups fill up with gum about once a month, or after four chippings. Each cup holds in the neighborhood of three pints. As the oleoresin flows over the face to the cup, some of it clings and thickens, causing an accumulation of fairly dry, resinous material on the face. This is allowed to remain until the end of the season, when it is scraped off and is processed like gum. The material thus removed is called the "scrape," and its removal is "scraping."

Oleoresin that drips into the cup is emptied, or "dipped," into barrels, usually wooden, then hauled to the distillery, or "still," where the second step takes place. The white, sticky "goo" is both turpentine and resin. Processing converts it into two separate products.

In earlier times, many of the farmers had their own "stills." This practice was difficult, costly and wasteful. Today the pure gum, as it comes from the tree, is sold direct to a company known as a centralized gum processing company.

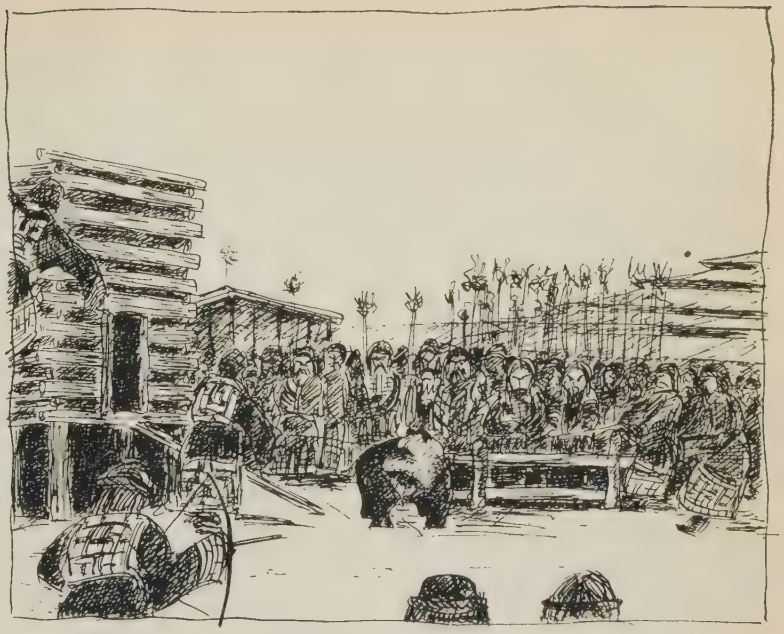
The distillery was a large wooden shed, two stories high. On the ground floor were the immense cookers, huge pots or vats in which the raw gum is heated. Aromatic fumes suggested a giant vapor-lamp. On all sides were large vats of freshly dipped gum, which had just been graded according to shade, ranging from light to dark. On the whole the gum had a whitish-gray cast, was thick, gummy and contained some small sticks, bits of bark and debris. All this was dumped into one of the massive cookers and scientifically cooked.

Many things happen during the cooking. A condenser tube—called a "worm"—draws off the condensed volatile oil, which (Continued on page 108)

Kamui Omande: Bear Festival of the Ainu

By WILLIAM SHEDENHELM

Illustrations by William Reinhold



The bear is taken from the cage and, while held with ropes, is pelted with blunt arrows by the villagers. In the center is the log strangulation device.

ALMOST every country has had its primitive peoples. Very infrequently they have been absorbed into the more advanced culture that takes over the land, but usually they are either dissipated and killed, or put on government reservations. This last was the case with our own American Indians. Other examples of these primitive groups in modernized countries include the Bushmen in Australia, the Indians in Canada, and the Negroid groups in parts of Africa. Japan, too, had such a people—the Ainu. Today there are less than fifteen thousand Ainu left in Japan, and for the most part they have so intermingled that they are all but indistinguishable from the Japanese. Slowly, starting about sixty years ago, they began to adopt more and more of the Japanese customs and philosophies, until today there are few who even know of the old Ainu legends and customs. Before this dissolution there were three main Ainu groups: those living on the northernmost Japanese island of Hokkaido, those on the southern half of Karahuto or Saghalien, and a much smaller group living in the Kurile Islands. The largest group today is that on Hokkaido, which contains about ninety percent of the remaining Ainu, and is among the last to be Japanized.

One of the most interesting things about the Ainu was their worship of animals, which differed from that found anywhere else in the world. In the observance of this religion they had no village shrines or temples, as have, say, the Shintoists, but each house usually had its own shrine, called a *chipa*, which was nothing more than a row of ceremonial wands, or *inau*, placed in front of the door. The Ainu believed that the gods were like men in appearance, but were invisible, and vastly preferred the earth to their own spirit homeland. Because of this liking for the earth and its beauties, they made frequent visits, disguised as fish, birds, animals, and insects. Thus, according to the Ainu belief, the bear was the god of the mountains in earthly form, the owl was the god of the village, and the dolphin was the god of the sea. As a matter of fact, every living creature was the god of something or other in disguise. With this as the central motif of their religion, it would seem to follow that the killing of any animal would constitute a sin of the most blasphemous nature, as it would for a Hindu to kill one of the sacred cattle. This was not true, however, because of the one factor that made the Ainu beliefs differ from all other animal-worship religions. While they fervently believed that the animals were their gods in disguise, they also believed that the only way in which these gods could escape from this disguise and return to their own land for a while was for someone to kill the animal that was their earthly, and earth-bound, manifestation.

When the Ainu huntsman would kill a bear in the mountains, he would return to the village, and a large group of men would go out to help carry the carcass back to the house of the successful huntsman. Here it was placed in the seat of honor before the fire. The people, believing that the god spirit did not leave the bear's body for several hours, spent the night dancing and singing, in order to entertain it. When they butchered the bear the next morning, the head was severed from the body and put back in the seat of honor, where it was repeatedly thanked for being so nice about the whole bloody thing, and was offered food and *saki*.

The more complex custom, and much more interesting from its standpoint of the contrast between religious feelings and a love of bear meat, was that centering around the three-day festival of *Kamui Omande*, or "God Bear." When a bear cub was captured, it was adopted by the family of the captor. If the cub was very young, it was suckled by one of the women of the family until it was old enough to eat for itself. During its early life the bear was not held in any particular degree of reverence by the people,

After the bear has been exhausted, his head is placed between two long logs, and he is strangled. In case the bear objects to the whole idea of the thing, there is always an expert archer on hand who shoots an arrow into its heart.

but played with the children around the house. When it grew too big for this, and occasionally bit someone too hard, it was placed in a wooden cage in front of the house, where it was still treated with no greater religious respect than being offered an occasional drink of ceremonial *saki*. When the bear was two or three years old, the festival of *Kamui Omande* was held, usually in November or December. After a long ceremonial apology to the bear for his coming death, during which the women wept and cried, the bear was taken from his cage, and held with ropes. The villagers then shot blunt-ended arrows at the bear until he became angry enough to put up a struggle. Usually the ropes held him, and he soon became exhausted from struggling, which was the point of this part of the ritual. When he was exhausted he was led to a spot near the family's *chipa*, or shrine, while the women showed their grief by wailing and clapping their hands in slow rhythm. At the *chipa* the bear's neck was placed between two long logs which everyone pressed on until the bear had strangled. In case something went wrong, or the bear objected too strenuously, there was always an expert archer on hand who shot an arrow into the bear's heart.

The body of the dead bear was carried to a mat in front of the *chipa*, while the villagers wept and lamented the death of their good friend, and told him how much they had liked him, and how they hoped that they had not hurt him too much when they killed his animal form. Presents were proffered to the dead bear, and offerings were hung around his neck. If the bear had been a male, they offered bows and arrows; if it had been a female, they offered jewelry. After a lot more weeping and soulful laments, and offerings of *saki*, they started to butcher the bear. The men usually drank the warm blood, and shared the liver with the women and children. The religion forbade them to leave until the bear was entirely eaten, so the festival often lasted more than the regular three days, during which they sang and danced between the courses of bear meat, to give the god a good send-off on his way back to the spirit world. They believed that the god was so happy at being released from its animal body that it gratefully left the people its flesh and skin as a souvenir.

On the third and final day of the festivities, the brains were scooped out of the skull and passed around, to be eaten with a little salt. Then the skull was placed on the central *inau* wand of the family's *chipa*. The collection of bear skulls was not forgotten, but were periodically sprinkled with *saki* or millet beer, to show the gods that the family still remembered them with due reverence.

In the last few years, with the modernization of Japan up until the war, these customs had all but died out, although there are still remote mountain villages on Hokkaido where the festival of *Kamui Omande* is held. With the present scarcity of food in Japan, a bear steak would probably be as much relished now as it was thirty or more years ago, before the last Ainu tribes had begun to be absorbed into the Imperial Japanese Government, and converted to more civilized ways, and less civilized philosophies.

★

A Reverie

By HARRIETT TULLOS

A pleasing day is pleasanter when viewed subconsciously;
To walk along a winding path in happy reverie;
To walk and muse . . . while faintly conscious of the meadow grass,
The pale blue sky with rolling clouds of chalky white en masse,
Perhaps a rippling stream that throws its brooklets past anew
And green trees coolly patterned in a panoramic view.

Plant World "Octopus"

By ZELMA GOSLEE LOCKE

Chicago Natural History Museum photograph of the habitat group presenting the strange desert plant, *Welwitschia.*

FROM South Africa comes a weird plant recently placed on exhibition in a habitat group at the Chicago Natural History Museum's Department of Botany. It is the *Welwitschia,* a strange desert growth with a life span of several hundred years.

Strap-shaped leaves grow like tentacles to lengths of six or eight feet, and radiate from the round, solid center or trunk of the plant, which grows to three or four feet in diameter. The trunk is short and is primarily a bi-lobed woody stem, rising little above the ground and growing mostly in circumference. It is a "tree" that spreads out on the ground rather than one that grows in a standing position.

Throughout its life this plant bears only two large leaves, which have a slow but continuous growth. A unique feature is that its two lone leaves split as they grow, giving the appearance of up to eight or ten arms. As the trunk grows larger, the leaves increase in width and split into the "straps," which die off and wear away at the tips.

The specimen is the only one, so far as known, in any museum or botanical garden of the United States, and only much smaller specimens are to be seen anywhere in the world outside Africa," says Dr. B. E. Dahlgren, Chief Curator of Botany at the Chicago Natural History Museum.

From the large size of old plants, which are several meters in circumference, and their great number of scars of cone-bearing branches, it is at once apparent that *Welwitschia* often reaches an age of several hundred years.

"Pollen and seeds are produced on separate male and female plants, and pollination is accomplished by the wind or by insects," Dr. Dahlgren says. "*Welwitschia* appears to be a relict from some past age, so different is it from any other modern plants. However, no fossil ancestors are known."

As a desert plant, *Welwitschia* has a root system that retains large amounts of water during long, dry periods. Most desert areas of the world support a scanty vegetation made up of a few species of plants able to withstand the vicissitudes of desert conditions. The scene shown in the habitat group represents the Mossamedes desert in the Portuguese Colony of Angola and is at the northern end of a coastal strip of desert, about fifty to sixty miles wide, extending for 500 miles southward to Walfisch Bay in central South Africa.

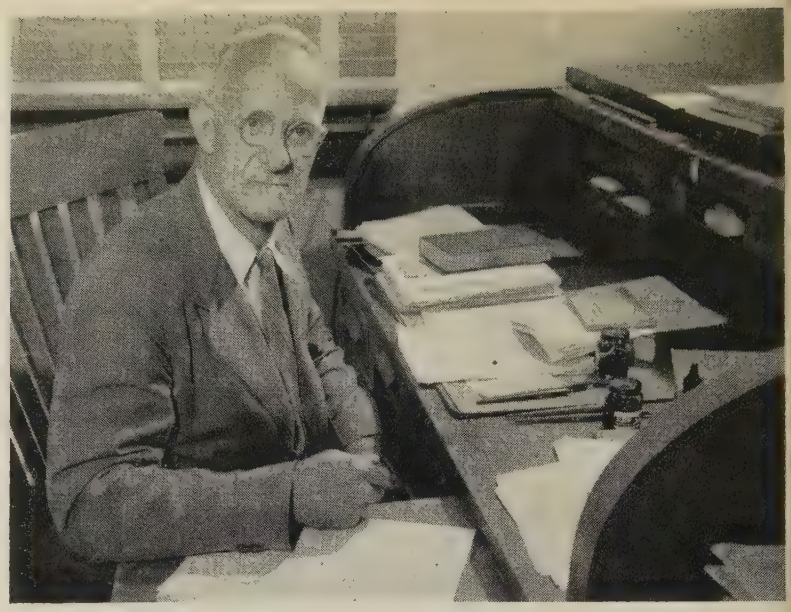
For a long time this strange plant was known only from isolated individuals in the Kalahari desert at the southern end of its area of distribution. In the Mossamedes desert it is more abundant, and can be seen growing along the sides of the usually dry streambeds. The other plants found in the locality, and shown in the group, are leguminous shrubs with much-reduced seasonal foliage and drought-resistant grasses.

The plant material and photographs for this habitat group were obtained for the Museum in Angola by Prof. H. Humbert of the Museum of Natural History in Paris, who was commissioned to do so.

The plant was first discovered in 1860 by a Portuguese government botanical explorer, Dr. Friedrich Welwitsch, an Austrian, and is named for him. The museum exhibit is a composite of the original trunk of the plant and leaves reproduced from the original specimen. The plant reproduction laboratories of the museum used a special process to simulate the living appearance. This work was done by Emil Sella, chief botanical preparator. The exhibit is completed in diorama form, and the background representing the African desert was painted by Arthur G. Rueckert.

Harry Allard's Day

By CHARLES E. GAPEN



HARRY ARDELL ALLARD, NATURALIST

HARRY A. ALLARD, who retired October 1 from the U. S. Department of Agriculture, where he carried on plant research work for 40 years, is a man of modest physical stature and mien. But he has an importance and persistence that belie these modesties. Some of those who know about his character and accomplishments like to think of him as a modern Thoreau who has had the advantage of an additional century of science.

Harry Allard apparently began his life with a practically insatiable curiosity as to the natural world about him—plants, birds, insects, sky, stars, streams, sun, air, night, day, rocks, noises, music, the composition of things, the stridulations of crickets and cicadas and cone-headed grasshoppers, the mysterious impulses that cause fireflies to flash and plants to bloom. It was a hobby that he carried on as he got deeper and deeper into his formal scientific work. One benefitted the other.

A mark of a substantial thinker in any field is a disposition to record thoughts, speculations, observations and findings. Allard began keeping a journal in his Oxford, Massachusetts, home when he was fourteen years old, and he is today adding lines to it with the persistence of a tree adding growth rings. The bound records of his ramblings, listenings, observations, and philosophizings, some typewritten, some still in longhand, piled one above another, practically reach the ceiling in his home. His published articles, 206 of them so far, and more about to come out, run from brief notes recording observations along faint woodland paths to probing speculations on main highways of research. The first article listed in his bibliography, "The Oven Bird," appeared in *Popular Science News* in 1898, when he was eighteen, after he had been keeping his journal for four years. (According to Allard, Thoreau called this bird the "night warbler" and the field sparrow the "huckleberry bird.") Then during the next eight years, which carried him through his course at the University of North Carolina, he published such articles as "The Song Sparrow," "Spring Flowers," "The First Field Cricket of Summer," "Some Bird Ways and Their Variations," and "Fowler's Toad." Most of these were in various popular science publications, the last one, however, in *Science*.

By that time Allard had been a year in the Bureau of Plant Industry, and his next published writing was based on formal research—"The Fibers of Long Staple Upland Cottons." Next came "*Bufo fowleri* in North Georgia," published in *Science*, and in the next two years came reports on formal research—"Observations Concerning the Improvement of Timothy" and "Notes on Cotton Breeding in North Georgia." Then a string of writings on salamanders, lizards, turtles, musical crickets and locusts, and a report on natural crossing in cotton. That was 1910.

The marbling effect of these different types of studies shown up to this time is carried out to the present. In the ten years before 1920 there were more and more reports of results of formal research on various peculiarities of tobacco and cotton plants, but Nature in general claimed his attention in leisure time for such matters as the music making of locusts and the doings of fireflies. In 1916 there were ten additions to his writings, three on mosaic diseases of various plants, including tobacco, tomatoes, petunias and another tobacco relative, and one on how environment affects the number of leaves and the character of flowers of tobacco plants. The other six were on insects, bullfrogs and toads. Allard's eyes and ears showed avidity for the varied manifestations of Nature. You might say he had an almost chemical affinity for new facts.

Something of unusual significance was to happen in 1920. The record of search- (Continued on page 108)

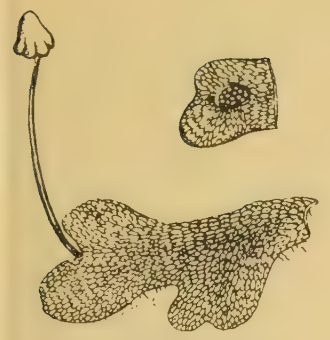
Pioneer Plants

Liverworts, Mosses, Club Mosses and Their Allies

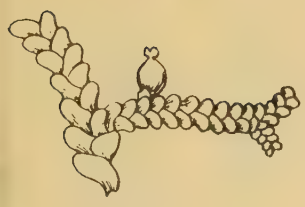
By E. LAURENCE PALMER

Illustrations by Elizabeth Burckmyer

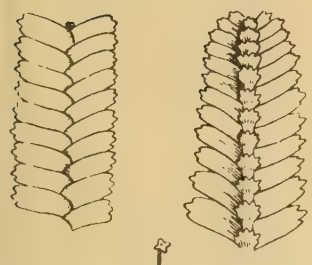
This is the forty-third in Nature Magazine's series of educational inserts.

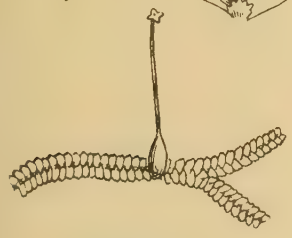


CONOCEPHALUM



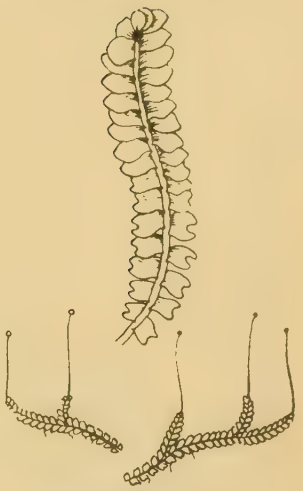
PORELLA





BAZZANIA

PTILIDUM



LOPHOCOLEA

MARCHANTIA

PEAT-MOSS

WHETHER we call these plants pioneer plants or frontier plants makes no difference. In either case, they are likely to precede other plants in the occupation of new territory, or to precede other plants in beginning their activities for the year. Of course exceptions can be found to such a generalization, but, for the most part, these plants do "jump the gun" on other plants in mastering both space and time.

Green patches under the snow; green patches on barren sand or clay; green patches on otherwise bare logs, roofs and tree trunks, on bare rocks, either wet or dry; green plants growing out at the edge of pond-occupying bogs—all these represent the pioneering instinct of these frontier plants. While knowing these plants in their habitats requires study, our interest should be stimulated by the fact that they make inconspicuous and conspicuous contributions to our general economy. Either directly or indirectly, these plants aid in soil development, help to solve the fuel problem, serve in the manufacture of pills, fireworks, toilet powders and in other ways.

Partly because these plants can be found at their best in mid-winter or early spring, we suggest their study at this time, when other plants may be on the inactive list. Members of this plant group usually transplant well in terraria, where they may be studied indoors. However, this distorts one's appreciation of them, and we recommend that one learn to know them in their natural setting. Also, some, like many of the deep-growing club mosses, do not ordinarily survive transplanting. Others have specific chemical needs not easily provided under controlled conditions. So, as is the case with most things in Nature, mosses and their allies are probably at their best in their native habitat.

In earlier inserts we learned how loose the English language is in speaking of nuts, of evergreens, of roots and of other things in Nature. The same looseness or even greater looseness is to be found when we speak of mosses. Each of the major groups of plants—Thallophytes, Bryophytes, Pteridophytes and Spermatophytes—include one or more plants improperly called mosses. In addition we have in the animal kingdom the bryozoans, or moss-animals.

Among the primitive Thallophytes are the green patches caused by such algae as Pleurococcus, often considered as moss when found on tree trunks. A book entitled "Sea Mosses" deals only with marine algae, not mosses at all. Many of the lichens, which are combinations of algae and

PURPLE HORN-TOOTH MOSS

COMMON HORSETAIL

SLENDER CATHERINEA

fungi, have distinctly moss-like characters that cause them to be called "mosses." No doubt much of the "gray moss," so frequently mentioned by poets to indicate abandon and neglect, is really a lichen and not a moss at all. Reindeer moss, which is the principal winter food of the caribou of the far North, is not a moss but a lichen with some very superficial moss-like qualities.

The gray "moss" that hangs from the live oaks and telephone wires of the South is really a true flowering plant closely related to the pineapple. The tourist guides usually speak of this plant as "Spanish moss," but since it is a flowering plant, it is not considered here. In the group of flowering plants, there are other plants that have moss in their popular names. There is the fuzzy moss rose, the moss pink, mossy-cup oak, mossy stonecrop and moss campion. While each of these may have at least a remote resemblance to the popular concept of moss, none is really a moss.

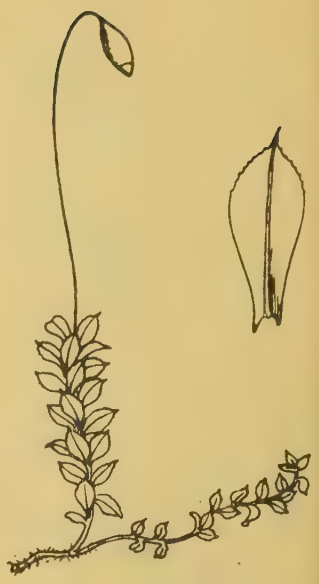
So loose is the use of the term moss that we often wonder what writers of prose and poem meant when they used the term. Was the "moss-covered bucket that hung in the well" covered with a true moss or with *Pleurococcus?* When we say "the stone that is rolling can gather no moss" do we refer to a true moss, or to a lichen? Certainly a "moss-back turtle" has its back covered with algae, rather than with a true moss, or one of its close allies.

One of the best references for the laymen for the identification of some of the plants with which we here deal is Conard's *How to Know the Mosses,* published by H. E. Jaques, Mt. Pleasant, Iowa. As an Iowa botanist years ago, I came to know and greatly to respect both of these men. I confess I was a bit surprised to find in Dr. Conard's book on mosses that he also presented pictured keys to the identification of the liverworts. From the title of the book it might be implied that Dr. Conard considered the liverworts as being mosses, and, since most moss books religiously avoid treatment of the liverworts, it was refreshing to find them presented in this book. I only wish that they might have been mentioned in the title, for there is no lack of excellent books on mosses, but far too few on mosses *and* liverworts.

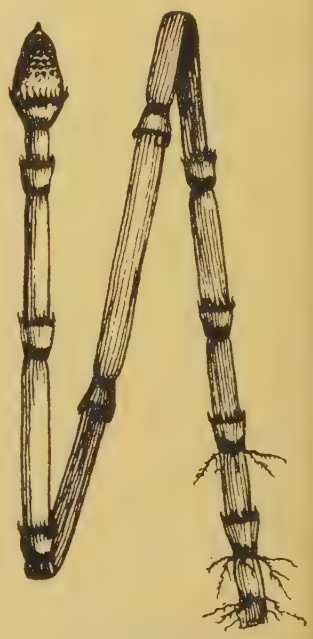
The plants we are here introducing belong to the divisions of the plant kingdom known as the Bryophytes and the Pteridophytes. Many will be surprised to know that the number of described Bryophytes, including mosses and liverworts, is approximately four times as great as the number of Pteridophytes described. There are some 4500 known species of Pteridophytes, including ferns, club mosses, horsetails and quillworts, and nearly 17,000 Bryophytes, including the liverworts and mosses.

To the botanist, an essential difference between these two main groups of plants is that the major conspicuous part of the Bryophyte bears truly sexual cells. The result of the union of these cells sometimes conspicuously results in the "fruits" of mosses. In this respect, the Bryophytes, at least superficially, resemble the Thallophytes, which are considered more primitive.

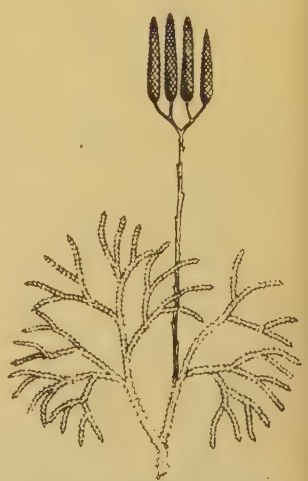
The Pteridophytes, on the other hand, have their conspicuous parts as plant-producing spores. One may have seen them dusting free from heads of club moss or horsetail, or dusting the under sides of some fern fronds. The



POINTED MNIUM



SCOURING RUSH



FLAT-BRANCHED GROUNDPINE

true sexual stage in these plants is a usually inconspicuous development of these spores. In this general respect, the Pteridophytes are like the higher flowering plants. So we have for our consideration in this insert two groups of plants representing intermediate groups among the groups of the plant kingdom.

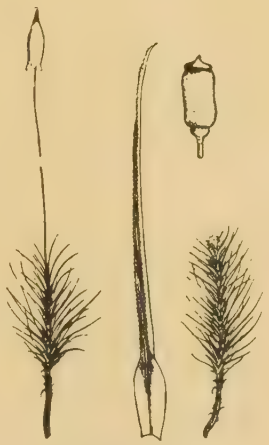
As a start in the study of these plants, we introduce here a half-dozen mosses, a half-dozen liverworts, and a half-dozen of the fern allies, which include the club mosses, horsetails and quillworts.

Superficially, one may decide whether a plant is a liverwort or a moss by remembering that most liverworts are essentially flat, that though they may bear leaf-like structures these are usually so arranged as to make a plane. Mosses, on the other hand, usually have their leaf-like structures arranged more or less radially around a central stem. The stem of mosses is more likely to be erect than the stem of liverworts, although some of the latter are definitely prostrate. If there is any conductive tissue in the liverworts, it is most rudimentary. It may be better developed in the mosses.

In such liverworts as the common *Marchantia,* we often find little cups on the surface of the thallus. If we examine these closely, we may observe small units in the bottom of these cupules. These small units may be freed into the air, or water, and if they come to rest in a suitable environment they will form new plants like the parent plant. In doing this, they avoid the necessity of sexual reproduction, which is, of course, more complicated. Such a short-cut system is not the practice among the mosses.

As one may gather from our illustrations, the liverworts vary considerably in their superficial appearance. The flat thalloid marchantias and conocephalums do not look much like the leaf-liverworts shown. I was sorely tempted to present another thalloid liverwort, *Riccia,* which often is so abundant that it almost covers the surface of the water on which it may float. It looks like a series of wedges or sections of pie, with masses of root-like structures beneath, and with conspicuous grooved lines indenting the upper surface. In these grooved lines are found the sex organs of *Riccia.* A less common liverwort is the horned liverwort, which represents the Order Anthoceratales. Superficially, this looks like a thin *Marchantia,* on the upper surface of which are short cylinders from whose tops extend grass-like structures that may divide in the upper part

COMMON CLUB-MOSS



COMMON HAIR-CAP MOSS

SHINING CLUB-MOSS

to free the spores. These plants may sometimes be found on clay banks that are continuously moist.

The mosses include two major groups or orders, the Sphagnales, or peat mosses, and the Bryales, or true mosses. There are probably few people who have not seen one or the other of these. When you buy some roses or shrubs in spring, the chances are excellent that the roots are packed in sphagnum moss for moisture. Because of the layers of thin-walled cells found in these plants, they are able to take and to hold water for a considerable length of time. Since they usually are to be found in areas where the water is strongly acid, they must depend to some extent on water that is taken from the air. The upper portion of these plants, soaked in rain, fog, or dew, lives on the remains of the dead lower parts immersed in water that cannot function well physiologically. These dead lower parts may be preserved for a long time and, since they have not decayed completely, may, if dried, be used as fuel in the form of peat. This peat provides the major fuel for considerable areas in the world.

The associates of peat mosses are almost as important to us as they are. Some of our finest cranberry bogs and blueberry bogs are basically peat bogs. Peat mosses helped to build much of the finest muck lands that produce our celery and similar garden truck. So, whether we are interested in the botany of these plants or not, we at least must be interested in the products of their associates. With the advent of frozen foods, the value of such bog plants as the blueberries is greatly increased. Today, we can preserve them cheaply and effectively so that they may be available in an essentially fresh form through the year. Much of the credit for the existence of these plants belongs to the mosses.

The true mosses are so universally present that anyone who has been outdoors at any time of the year must have seen them. One will find them when climbing mountains or at sea-level; on dry sand or clay, or under water in our freshwater streams. There is no need here to repeat structural and other details about these plants since these are presented in the tables, but there are a few pertinent suggestions about field work with mosses. Whatever the time of year, it is a good time to study mosses. Of course, one of the best times is in February, because, then, in northern regions, other plants are not so (Continued on last page of insert)

COMMON NAME	CONOCEPHALUM	PORELLA	MARCHANTIA	SCALE-MOSS LIVERWORT
SCIENTIFIC NAME	*Conocephalum conicum*	*Porella platyphylloidea*	*Marchantia polymorpha*	*Ptilidium pulcherrimum*
DESCRIPTION	Largest of our liverworts with broad flat thalluses, in this case often covering many square feet of surface. Plant body is paler green than is *Marchantia* with marked areas on the upper surface, larger and more distinctly defined, these often being sufficiently large to be recognized many feet away. When the thallus is broken, it gives off a strongly resinous odor.	Stems: to over 3 inches long, branched, prostrate, slender and hidden by the closely overlapping thin leaves each of which is blunt at the tip, to nearly 1/20 inch long, but the whole plant with its many branches covering an area sometimes many square feet in extent. Beneath the closely overlapping leaves are underlobes and underleaves that hug the stems.	Dull green, forked ribbons, to 5 inches or more long, with prominently sunken midribs above, with upper surface marked off in diamond shaped areas each with an oval or circular dot in the center. On close examination, the diamond areas are really 8-sided and the pores are air holes leading to the interior. Under side of thallus crowded with root-like structures.	Leaves: without any midrib, in 2 rows near upper side of the stem, deeply divided into fine lace of threads or rows of cells, but with these joined into a substantial base that is from 6 to 20 cells wide as contrasted with narrower-leaved genera, often somewhat purplish brown in general color, to 1/25 inch wide with the leaves spreading when moist and close-pressed dry.
RANGE AND RELATIONSHIPS	A liverwort belonging to the Family Marchantiaceae. It is distinguished from *Marchantia* by characters suggested above and by the fact that the air pore in each surface segment is borne on top of a low mound of colorless cells. Like *Marchantia, Conocephalum* is found widely distributed over North America and Europe.	A liverwort belonging to the family Porellaceae. While *Marchantia* and *Conocephalum* belong to the order Marchantiales or thalloid liverworts, *Porella* belongs to the leafy-liverworts of the Order Jungermanniales. Two species of the genus are recognized but are difficult to distinguish one from the other. They are widespread in North America and Europe.	A liverwort of the Family Marchantiaceae which includes *Lunularia* of greenhouses, *Conocephalum,* and *Preissia.* Marchantia is found all over North America and Europe with this species most common in the North and with two other closely related species in the South.	Leafy liverwort belonging to the Order Jungermanniales and the Family Jungermanniaceae. In this country, the genus is represented by this species and the wider-leaved *P. ciliare,* both of which are circumpolar and extend in America south to Pennsylvania and Illinois, and by *P. californicum,* which ranges on the West Coast from Alaska to California and Idaho.
REPRODUCTION	Male sperm-bearing antheridia are borne in a wart-like spot on the thallus rather than on a tall flat-topped antheridiophore as in *Marchantia.* The female archegoniophore looks like a partly-closed umbrella with a long handle. It is watery and does not last long. It usually matures somewhat earlier than does *Marchantia.* Asexual spores are borne in remarkably shallow cups.	Male and female reproductive organs are borne in separate structures on separate plants so that a plant is either male or female. They appear as small buds on the branches and the fruits look like little cups that mature to free the spores in May or June. They are not conspicuous in comparison with the developments to be seen in *Marchantia.*	Thallus is either male or female. Male thallus bears erect, flat-topped structures that bear the antheridia that produce the spores that make their way by swimming to the female structures. Male structures are antheridiophores. Female plants bear umbrella-like archegoniophores beneath branches of which are the eggs that produce the yellow sporophytes. Asexual reproduction.	From the axils of the branches there frequently appear what seem to be white "hairs." At the tips of these, are small black capsules. In these capsules, the spores ripen and are ready to be shed in the spring. The capsule may persist on the plant after the spores have been shed, and the supporting hairs after the capsules have been shed.
ENVIRONMENTAL NEEDS	Found for the most part on moist earth or on the dripping rocks of gorges and glens, often entirely covering considerable areas to the practical exclusion of other plants. Do not expect to find the spore-producing umbrellas in late summer when *Marchantia* may be in excellent fruiting condition.	*P. platyphylloidea* usually lies flat on bark of living trees though the tips may be raised. *P. pinnata* is attached to rocks and is generally submerged. *P. navicularis* is conspicuously glossy, is found on our northwest coast on trees and logs; and *P. cordaeana* and *P. roellii* are also native of the northwest areas.	Plant usually most abundant on newly disturbed clayey or silt-filled soil particularly in burned areas. May thrive in crevices between stone flagging. Umbrella-like structures develop even though eggs are not fertilized and reach maturity through June to August. Spores are forced from the capsules of the sporophytes by spring-like structures.	Plants are most conspicuous in early spring when they appear most commonly on rotted wood or on tree trunks. They are frequently found mixed in with mosses. Usually, the botanists who are interested in these liverworts use the leaves as a basis for distinguishing the species, the important characters being the number of lobes and the number of hair-tipped lobe divisions.
ECONOMIC IMPORTANCE	Probably of little economic importance though it was once thought to have some medicinal properties. It must serve to some extent to anchor soil as well as to add organic material to small patches of soil that must be more or less sterile. It does not appear so commonly in the literature of the biology class.	Plants are of little importance economically and are of interest to botanists who find in them interesting variations in reproductive habits as well as in branching and leafing habits.	Plants are of little economic importance but are most commonly used for illustrating development in the bryophytes in classes in biology. Plants lend themselves readily to culture in terraria. May serve some purpose as soil anchors in areas where other plants could not survive.	Plant is probably of no economic importance whatever, but it does appear as an attractive decoration for a tree trunk or a fallen log.

THREE-TOOTHED BAZZANIA *Bazzania trilobata*	VARIABLE LOPHOCOLEA *Lophocolea heterophylla*	BOAT-LEAVED SPHAGNUM PEAT-MOSS *Sphagnum palustre*	COMMON HAIR-CAP MOSS PIGEONWHEAT MOSS *Polytrichum commune*	COMMON FERN-MOSS *Thuidium delicatulum*
Stem: branching, prostrate and closely crowded with overlapping leaves that seem to form a continuous frill to either side. May form a solid patch to 2 feet across. Leaves are 3-toothed at the tip, bend towards the ground when they are dry, are firm and green or brown. Leaf and branch are to ⅛ inch wide and individual branches are rarely over 5 inches long.	Stems: trailing, slender, with root-like structures beneath. Leaves: bright green if growing in exposed sunlight. Underleaves: small and inconspicuous. Upper leaves: some entire and others deeply 2-toothed hence the name *heterophylla.* In the related *L. bidentata,* the leaves are broadest at base and with 2 long pointed lobes.	Stems: weak but crowded compactly together to form great mats sometimes acres in extent with the upper foot living and the lower portion in varying degrees of decay. Erect stems are covered with leaves as are the branches, the leaves being broad spoon-shaped or boat-shaped with the tips turned back from the stem. Spiral lines on walls of stem scales.	Stems: to 1 foot long, erect, crowded. Leaves: crowded, to ¾ inch long, with enlarged, silvery, shining base, with margins toothed at least to the middle. In related *P. juniperinum* leaf margins are translucent and rolled over the upper leaf surface. Plants often form pure stands covering areas yards across.	Stems: loosely branched in a feather-like manner the divisions being often subdivided. Plant appears to be loose, weak and sprawling and somewhat fern-like. Stem-leaves: crowded, enlarged at the base. Branch leaves: broadly oval, concave at base, long pointed at tip, with toothed margins. Often forms mats several feet across.
A leafy liverwort of the Order Jungermanniales and the Family Jungermanniaceae. It is found east of the 95th meridian and in Europe. In Washington State it is represented by *Bazzania tricrenata* and there are five other species recorded as being found in North America.	A leafy liverwort of the Order Jungermanniales and Family Jungermanniaceae. This species common over wide areas in the United States, southern Canada and Europe. Closely related *L. minor* is about half the size of this species. *L. bidentata* and *L. cuspidata* are found in much the same range.	In North America, there are 6 species of *Sphagnum* with the walls of stem scales marked with spiral lines. The plants belong to the Family Sphagnaceae of the Order Sphagnales, in which the spore cases open by a circular lid with the opening unguarded by teeth. In this species the branchlets are stout and in large heads not slender pointed.	*P. commune* and *P. juniperinum* have a general distribution over the Northern Hemisphere, with some related species rather limited. *P. piliferum* requires sand or rocks as a base for growing but is found from sea-level on the Atlantic Coast to elevations of over 12,000 feet in Colorado. All belong to Family Polytrichaceae.	Found from Labrador to British Columbia and south to the Gulf of Mexico. At best in moist shaded places. Closely related *T. recognition* is stiffer, more yellowish, with shorter, broader stem-leaves. At least another half dozen common species also referable to this genus, which belongs to the Family Leskeaceae.
Rarely found in a fruiting condition. Sex organs appear as buds from the sides of the branches. Male organ is a leafy structure while the female is a stalked capsule, or rather produces a stalked capsule that usually reaches maturity sometime late in the summer. One of these plants in fruit is a find many botanists never make.	In *L. heterophylla,* sex organs are borne close to the stem, the female looking like a leafy bud that produces a body bearing a small egg-shaped capsule that sheds spores in May. Sex organs mature in autumn but the sporophytes do not appear in nature until spring though they may develop in January in the laboratory. *L. bidentata* has male and female organs on separate plants.	Male and female organs in this species are on separate plants, the male plants being thick, coarse and yellow, brown, green or red. The spores are borne in a capsule at the end of a stalk that is gametophyte rather than sporophyte, thus differing from the true mosses and being like the other peat mosses.	Male and female organs are borne on separate plants the clusters bearing the male organs being terminal and swollen into a flower-like structure. Sporophyte consists of a 4-inch stalk bearing at the end a capsule that is almost cubical, and which at first is erect and then horizontal, and is capped by a blunt, short-tipped cap and a hood-like calyptra.	Leaves around the female sex organs bear long hairs along the upper margin. Fruits are usually not abundant, do not form readily and do not appear normally until autumn. Capsule is borne on a long stout stalk and at maturity is conspicuously curved. Lid is conical and spores mature in mid winter. Cap is split up one side.
Found usually on moist shaded logs or rocks and while they usually cling close to the supporting surface through most of their length, they may turn upward at the tips. Structures that appear to be rootlets are borne at intervals along the under sides of the trailing stems. The plant may be found in woodlands or in marshes but is essentially a shade lover.	Common for the most part on shady banks, on rotten wood or sometimes exposed to strong sunlight. This is the general habitat of most species of the genus. In both *L. bidentata* and *L. cuspidata,* the leaves are broad based and divided into two long, pointed lobes.	Plant is one of the common bog builders. It can take water from the atmosphere by means of the absorbent cells on the branchlets and stems, and thus is independent of water from beneath. In bogs and places where this moss grows, the water may be abundant but may also be physiologically useless.	Common in woods or at edges of peat bogs or in other relatively infertile places where they may form clear stands. They do not absorb water from the air as do the associated sphagnum mosses. The family is characterized by having from 32 to 64 teeth at the capsule mouth and a light membrane over the capsule mouth.	One of the prettiest and daintiest of mosses, found not only in North America but in South America and Europe as well. It may cover stones in flowing streams or be found on drier ground. It may also be found growing on the roots or trunks of trees.
Not of any significant importance economically, and not commonly recognized by botanists except by specialists in the group. Most introductory botany texts may mention the order and may figure one of the plants, but they rarely do more than this.	Not of any recognized economic importance. Attractive when well developed but serves little purpose and does little if any injury to anything.	Plants are used as fuel either from recent plants or from the peat they produce. They are also used as absorbent materials in surgery, or for holding water in packing around trees and other living plants in the process of being marketed. Peat is built by these plants at the rate of about 1 foot in 100 years.	Of little economic importance though the plants have sometimes been used as a cheap stuffing for pillows and upholstery. They may serve some purpose as soil anchors, as holders of water, and as soil makers. The plants are commonly used for study in botany classes because of their size and abundance.	Merely a beautiful little moss known sometimes as the dainty cedar moss and named *delicatulum* or "dainty" by the great botanist Linnaeus. Ordinarily, it is not a difficult moss to identify. Related *T. abietinum* is cylindrical when dry and with stems only once divided, and *T. minutulum* appears chain-like dry because of curved leaves.

COMMON NAME SCIENTIFIC NAME	SLENDER CATHERINEA *Atrichum angustatum*	POINTED MNIUM *Mnium cuspidatum*	COMMON HORSETAIL *Equisetum arvense*	SCOURING RUSH *Equisetum hyemale (prealtum)*
DESCRIPTION	Stems: slender, a few inches tall at the most, well covered with slender leaves. Leaves: with midrib like structure composed of 4 to 7 folds and covering half of the leaf. Leaf bases do not sheathe the stem. Under a microscope, the tip margins are finely toothed for most of the upper half; curl conspicuously when dry.	Stems and young leaves are bright green becoming much darker with age. Leaves are toothed slightly along the margin of the upper half and the midrib continues to form a prominent tip. Leaves near the top of each branch are definitely larger than those lower down. Plants are from ¾ to 1½ inches high.	Sterile stems appear after the fertile ones have died back in late spring. Sterile stems are pale green, with whorls arising from the joints, are to 2 feet high with the branches branched or unbranched. There are 12 to 14 furrows on the rough stems. Sheaths at base of joints are funnel-shaped.	Stems are to 3 feet tall, arising from a horizontal branching underground system, hollow, evergreen, grooved, with short sheaths at the joints but no branches such as are evident in *E. arvense.* Sheaths at joints have blackish teeth, and disappear early in the season. Stems are rough and much coarser than in *E. arvense.*
RANGE AND RELATIONSHIPS	Very common in the northeastern part of the United States particularly on half-shaded, hard, compact soil. Related *A. macmillani* is smaller and more dense. *A. undulatum* with its purple capsule is common in the Great Plains area, and *A. crispum* with smooth leaves grows on peaty soil from New Jersey to British Columbia and Oregon.	Common particularly in the central and eastern parts of the United States. In the northwest, *M. venustum* with all stems erect and a necked capsule is common, while *M. medium* with large leaf-cells is found in Europe, across North America and to the North.	Native of North America as well as of Europe and Asia. Found in America from Newfoundland to Alabama and west to Alaska and California but possibly more common east of the Mississippi than west of it. Related *E. sylvaticum,* wood horsetail, and *E. pratense,* thicket horsetail, also have sterile stems separate from fertile stems. Order Equisetales. Family Equisetaceae.	Found native through most of the United States and Canada, and so closely related to European species that many question that there is any real difference. Certainly it is slight. The species name *prealtum* is applied to the American form and *hyemale* to the European form.
REPRODUCTION	Male and female organs are borne on separate plants. Male rosettes are conspicuously bright red, while the females are not conspicuously developed. The developed sporophyte is a dark green or purple capsule, mostly cylindrical and curved, with a beaked lid and one-sided cap, and borne on inch-long shining red stalks.	Male and female elements are borne in the same cluster. From the fertilized egg develops the sporophyte with its slender, pale stalk from the end of which droops the neckless capsule from which the spores are freed in spring. In this species the sterile stems may bend over, root at the point of contact, and reproduce in this manner.	Fertile stems arise early in season from horizontal underground stem, reach a height of 10 inches, appear weak, flesh-colored or brown, and terminate in a cone-like spike about an inch long from which clouds of spores are freed. These spores make small plants that bear either male or female sex organs.	Fertile part is borne at the top of the stem and appears like a small cone-like spike that is erect and only slightly thicker than the diameter of the stem at the point of attachment. Cones mature and free their spores from May to September and of course persist through the year.
ENVIRONMENTAL NEEDS	Most conspicuous from late autumn to early spring when patches of plant may stand out conspicuously on the ground in woods and along roadsides, in North America, Europe or Asia. It may form a sort of felt cover for otherwise naked stones.	Favors ground that is well shaded and not too dry, the plant being relatively delicate in comparison with some other mosses. It survives dryness by crisping the leaf margins thus reducing the area exposed to drying. Related *M. venustum* does not reproduce with its sterile stems, as outlined above for this species.	Found in fertile or in sandy soil such as on railroad embankments, in road cuts or in thickets, woods, open meadows or other places, irrespective of whether soil is acid or alkaline. Roughness of stems due to silica deposited in the stem surface. Ash from burned stems may still be rich in fine silica.	Common in springy or dry, sandy, open banks or in woods, in noncalcareous or alluvial soils, on railroad embankments, on stream borders and any moist sterile slope, often making an almost pure stand over a considerable area. It is not evident in soils that are excessively acid or excessively alkaline.
ECONOMIC IMPORTANCE	Apparently of no recognized economic importance, although it must make some contribution to the story of soil making and possibly to soil erosion. Plant is sometimes listed in literature as *Catherinea* rather than as *Atricum,* a difference of opinion significant primarily to systematic bryologists.	Of no obvious economic importance. It does come up for consideration rather commonly in classes in botany in college and high school levels and it lends itself well to culture in terraria and is popular in this connection. It may serve some purpose in soil making and in soil anchorage.	Useful as soil anchors because of branching underground parts. May become a pest in some fields but is usually easily controlled by cultivation. Interesting because of the fact that much plant life of the Carboniferous time, when much of our coal was laid down, was of this type although much larger.	Useful as a soil anchor either at stream edges or on bare steep exposed slopes. Stems have been used as scouring rushes because of the imbedded silica that helps remove grease and dirt, or the ashes may be used in making a scouring mixture effective because of the persistent silica. Import food of wild geese in Spring.

SHINING CLUB-MOSS *Lycopodium lucidulum*	COMMON CLUB MOSS *Lycopodium clavatum*	FLAT-BRANCHED GROUNDPINE *Lycopodium complanatum*	QUILLWORT *Isoetes engelmanni*	PURPLE HORN-TOOTH MOSS *Ceratodon purpureus*
Stems: trailing, branching, rooting where in contact with the soil and ascending at the free ends to a height of nearly a foot. Leaves rather evenly distributed over the stem but with year's growth usually relatively well marked, shining dark rich green about ¼ inch long and arranged all around the stem.	Stems run along just under the surface of the ground or at the surface forking freely and growing to great length, rooting at intervals where contact with the ground is established. Usual height is to about 10 inches. Leaves: crowded, about ¼ inch long, bristle-tipped, silvery green when new and dark green when old.	Long horizontal branching stems at or just beneath the surface of the ground bear erect branches. Stem forks freely and erect branches are to 5 inches long, which may grow about 2 inches a season. Leaves are of two kinds and are arranged in four rows to make a flattened frond which fans out widely in more or less of one plane.	Plant appears to be much like a tuft of grass, but the bases of the leaves are swollen and bear masses of spores, and the leaves are not sheathed to a stem as in grass, and are more delicate than the usual grass leaf, somewhat 4-sided. They may be to 20 inches long in some species, but are always in rosettes that arise from a branching root-system.	Stems: rarely over 3 inches long, erect, densely crowded, branching, leafy. Leaves: lance-like, keeled, with irregular margins, with tips commonly somewhat curved backward, bright green in winter but purplish in summer and fall, with margins curled, very narrow and, when dry, very wrinkled, sometimes distinctly reddish brown.
Native of North America and found from Newfoundland to Alabama and west to Missouri and Washington. Not usually common in the lowlands and at its best in Canada possibly where it is found clear across to British Columbia. There are a number of closely related species.	Found widely distributed over the world. In North America, is found from Labrador to North Carolina and west to Washington and Alaska, with closely related species extending the range. It is found at high altitudes in the tropics in both hemispheres. Fruiting regions are longer than in *L. annotinum*.	Native of North America and found here from Newfoundland to Georgia and west to Kentucky and Idaho. Systematic botanists contend that the species *L. complanatum* really belongs to a more northern variety, while the plant long considered as of this species is really *L. flabelliforme*.	Found in marly ponds, in the mud and in rivers and streams and lakes from Maine to Pennsylvania and west to Missouri and Illinois. At least 5 species are recognized in the eastern United States region based largely on microscopic characters of the spores.	One of the commonest of the true mosses, particularly in places that become very dry as on roofs, dry walls, at edges of flagging or on dry lawns. This is the common species of the genus. Closely related genus *Ditrichum* has smooth, erect capsule while this one has ridged and more horizontal capsule.
Reproduction is by division of the vegetative parts or by the shedding of special reproductive structures which are freed from the upper parts of the branches and are somewhat triangular and wafer-like, or reproduction may be by means of spores, which are shed and form underground plants.	Spore cases in cylindrical spikes borne on forked branches which have few and well separated leaves. Sterile leaves are entire and bristle-tipped, while in *L. annotinum* they lack the long bristles. Spores mature in August and September, and are freed in great clouds when ripe.	Fertile branches are forked into 3 or more sections and are to 4 inches long or about equal to the erect sterile part. They are poorly supplied with leaves in the lower parts but the spore bearing part is closely crowded with spore-bearing leaves that are more or less yellow.	Bases of the leaves are really sacs of spore cases with some bearing large spores with the outer ones bearing the larger spores that produce plants which bear the eggs, while the smaller spores are produced in the bases of the inner leaves, and produce plants that produce the sperms which fertilize the eggs.	Male and female organs borne on separate plants. From the fertilized egg arises the sporophyte with a stalk almost as long as the stem of the plant, slender and usually conspicuously glossy. Capsule at the end of stalk is dark chestnut or reddish brown, furrowed and held in an almost horizontal position at an angle with the stalk.
In suitable areas this may be frequent in damp, gravelly or sandy woodlands or in deep humus but more particularly in woodlands in which hemlock is found growing. Spore cases are bright yellow and become mature from August through September. They are borne at the bases of the uppermost leaves.	Found in open fields or woods or mixed with grasses commonly on soil too poor or sterile to support other plants, but usually on soils relatively free of lime. May do well on sand or gravels that would support few competitive plants.	Found in open woodlands or on dry gravelly banks doing reasonably well in a soil of some acid content, but not on soils rich in lime. The spores are wind-blown and germinate to produce underground sex-organ-bearing structures that are small and rarely known. From these arise the plants we see.	While these plants are found in or near marl ponds in which there is much lime they are usually not found where the soil is strongly acid or strongly alkaline. They may be found on almost dry shores, in gravel or relatively deep in lakes and completely submerged. Plants reach maturity in July-September.	The change in color of these plants from bright green in winter or early spring through brown to purple in summer and fall is rather spectacular. While the soil or surface on which the moss grows may be genuinely dry for a major portion of the year, it must be moistened occasionally if the plant is to survive.
In the club mosses the conspicuous part of the plant is essentially spore-producing (sporophyte) while in the true mosses the conspicuous part bears real sex organs whose fertilized egg produces the spore-bearing part of the life cycle.	Used in making Christmas wreaths, unfortunately. Spores used in expensive toilet powders, as coatings for pills to prevent them from sticking together, and to form a basis of flashlight powders and in certain kinds of fireworks. Plants collected by campers to fill mattresses, but are too slow growing to survive excessive collecting.	Plants are used somewhat in the making of Christmas decorations and the spores have uses similar to those suggested for *L. clavatum*. For general characters of club mosses see account of *L. lucidulum* on a previous page. Worthy of protection. Undoubtedly useful to some extent as a soil anchor.	Probably are of little or no economic importance but are tremendously interesting to botanists who consider that they represent a degree of development of the pteridophytes that is approximately equal to that of the more primitive seed plants.	Of little or no economic importance unless it may be considered as a soil maker or as a soil anchor. It may serve crudely as an indicator of humidity by the position of the leaves. It is at its best in early spring and does little during the summer months.

(Continued from third page)

interesting to study, and because many mosses really begin their major developments at that time. Since the sperms that fertilize the eggs of mosses must swim, it behooves them to be active at a time of year when water is likely to be present. They are ready to start their travels soon after the new year begins.

One will probably find some mosses this spring that look as though they had true flowers at their tips. These are likely the clusters that bear the male sex organs. If one will pick a few of these and squeeze them firmly between the fingers, so that the pressure is applied from the base of the cluster upward, one will be able to see the green, worm-like antheridia that are forced outward. From these antheridia come the sperms that make their way to the eggs, commonly on some other moss plant some distance away.

Possibly of equal interest is the way in which our common mosses shed their spores. Late in February, or in early March, one may find a patch of mosses beside a snowbank. These may already be bearing their spore-cases, showing that the sexual story has been completed for these plants for the year. Tap a few of these cases and delicate clouds of spores are freed into the air, if conditions are suitable for this to take place. If they are not, beating the plants vigorously will free no spores. The reason for this is that the freeing is regulated by teeth that guard the opening of the spore cases. If the conditions are right, these teeth not only permit but urge the expulsion of the spores.

COMMON FERN-MOSS

QUILLWORT

If one becomes a moss fan, one will probably want to make collections of the kinds of mosses found. These can be kept in small, paper envelopes on which should be written the data regarding date and place of collection, or the mosses may be mounted as with ordinary herbarium specimens. For a city dweller, with limited space for the storage of specimens, moss collecting may be ideal, since an ambitious collection may occupy a much smaller space than even a small collection of the ferns or flowering plants. Anyone with moss collecting ambitions should get Conard's book, suggested earlier, or Grout's *Mosses with a Handlens,* or Dunham's *How to Know the Mosses.* Some may wish to start with the dime leaflet on mosses by Dr. Grout, published by the Slingerland Comstock Company of Ithaca, New York. One should not hesitate to become interested in these plants because of little training in botany. Many of the best bryologists have had their training primarily in other fields. The authority on mosses at Cornell, for example, is the man who tried to teach me German nearly forty years ago.

These inserts have repeatedly called attention to groups of hobbyists whose interests are primarily cactuses, shells, fungi, ferns, or other specialties. An equally rabid group of hobbyists is interested in the mosses. They rally under the banner of the Sullivant Moss Society, whose president is Dr. Henry Conard of Grinnell, Iowa. If one is interested in these plants, and in these bryologists, as they call themselves, one can do nothing better than get in touch with Dr. Conard. While I collected weed seeds on the state field trips of Iowa botanists, Dr. Conard was with us and collecting liverworts and mosses.

Now as to the club mosses and the other fern allies presented in this insert. If Dr. Conard of Iowa, and Dr. Grout of New England, and Dr. Frye of the State of Washington, can be considered the advocates of the mosses before the court of public opinion, then few will question that Willard Clute of Indianapolis, Indiana, is the spokesman for the fern allies. I am almost positive that this insert will bring some response from him, praising anything that may be good about it and criticising unmercifully but honestly any error I may have made. He is the kind of critic we need in the field of natural history. He will probably hold that the whole insert should deal with the fern allies, and perhaps his judgment would be good. Unfortunately, these inserts can introduce one only to a particular field of interest. So, if one wishes to know more about the fern allies, I suggest he read Clute's *The Fern Allies.* It is a masterpiece. Another good reference would be Wherry's *Guide to Eastern Ferns.*

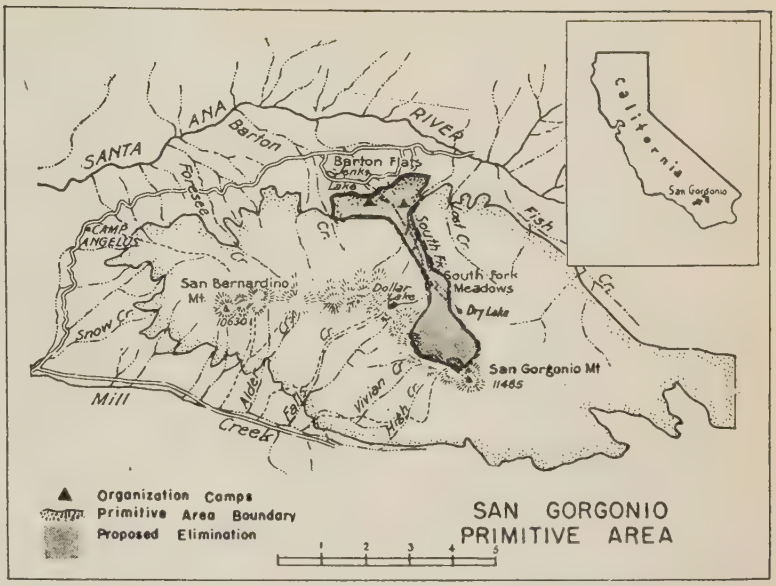
The club mosses are best known to the public because of their use in Christmas wreaths. Because of this popularity, many of them have been badly abused, and are now rare in places of former abundance. Usually, they have long, trailing, underground portions that are useful in the making of the wreath. The spore-bearing tops yield great clouds of spores, which are used to coat pills, to make toilet powders, and in flash-light powders and fireworks.

The horsetails are so common and conspicuous that most people have seen one or another of the various species. One interesting thing about them is that, while the spores seem to be identical in a given species, one spore will produce a plant that bears only female sex organs, while another, apparently just like it, will produce a plant that bears only male sex organs.

The club mosses and horsetails are tremendously interesting to students of the past. These plants, or their ancestors, constituted the major portion of the vegetation of the country during the time when our great coal measures were laid down.

If you wish to establish yourself as authority on any group of organisms in your neighborhood, I can suggest nothing better than that you work on the fern allies. They are relatively few in number, and easily learned.

Skiing on San Gorgonio?



ANNOUNCEMENT by the United States Forest Service that a hearing will be held in the San Bernardino municipal auditorium on February nineteenth brings definitely to a head the question of the future of the San Gorgonio Primitive Area in San Bernardino National Forest, California. The issue involves the proposed modification of the area from its primitive character by cutting out a deep corridor—as shown in the map—constructing a highway terminating in a hotel-resort, and building a ski-lift up the slope of Mount San Gorgonio.

Offhand this would seem to be purely a local question. It is, in our opinion, much more than this; indeed, it is a national question because it involves the principle of modification of a wilderness area to satisfy a special demand. Precedent is the delight of any special interest, since it makes smoother the path to exploitation.

We certainly have no quarrel with those who ski, and, admittedly, southern California is not blessed with places where skiing is possible. By the same token, primitive forest areas are equally rare there. Also, San Gorgonio is relatively closer to considerable centers of population than any other feasible site. Furthermore, although the skiers would benefit by this development, this is a commercial exploitation out of which the operators of the resort and the ski-lift expect to make money.

We have not personally studied this area, but we have the utmost confidence in those who have done so and have reported their findings. For example, Olaus J. Murie, Director of the Wilderness Society, reporting in *The Living Wilderness*, says that the city has moved up into the forest, adding:

"So far the mountain top itself has been kept inviolate, for those who seek the solitude of primitive forest and who like to climb mountains. About twenty-five organizations have camps on this part of San Bernardino National Forest and use the primitive area for their recreation. Numerous individuals also drive as far as they can go and then hike into the primitive area. Surely these people, as well as the skiers, have a claim on the mountain. Once destroyed, primitive areas are gone for good. Ski facilities require good roads, and roads would move the city up on San Gorgonio itself."

Especially interested in this issue is the Sierra Club, and the winter sports committee of this organization adopted a resolution declaring: "While recognizing the superior value of the San Gorgonio area for skiing, the committee believes that because of its unique summer value as a wilderness its boundaries should be retained."

Study of the issue was made on the spot by the conservation committee of the Sierra Club, which reached the following conclusion:

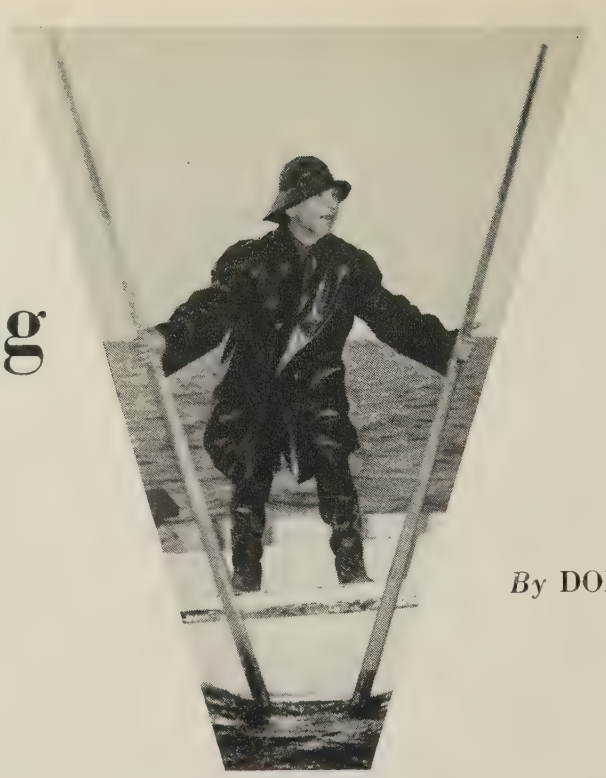
"In view of the peril to the concept of wild and wilderness areas if the boundaries of those areas are to be modified to suit demands of specialized activities at the expense of other users, this committee recommends to the Board of Directors that no revisions be made which would alter the wilderness character of this area."

On the basis of these reports the directors of the Sierra Club urged the acquisition of all privately owned land prior to taking any action which would increase the value of such land or provide access thereto; the making of a complete factual study and the formulation of specific plans prior to holding any hearing on the modification of the boundaries of such area; the recognition that the preservation without impairment of the unique wilderness character of this area is paramount to the construction of the proposed ski facilities.

A hearing, however, has now been set, thus making the issue of immediate concern. On the basis of the evidence we believe this invasion to be unwise. We regard the precedent such exploitation would establish to be dangerous to the integrity of the wilderness area policy and program, and, indeed, to the integrity of our National Park system, toward which exploiters are ever casting envious eyes.

Obviously attendance at the February hearing will be possible largely to those geographically close to San Bernardino. However, any statement of opinion may be filed with the Regional Forester, U. S. Forest Service, San Francisco, California. Conservationists who hold dear the hard-won progress in wilderness preservation should make themselves heard.

What Is Happening to Our Atlantic Oysters?



An oyster-tonger working in his dory. Oyster tonging is hard work. The tongs, bolted together, open and close as do scissors to bring up the shellfish from the oyster beds below.

By DOROTHY PARKER ROWE

IF YOU like oysters, no doubt you are ready to sing their praises on the least provocation. Nineteen centuries before the Walrus and the Carpenter, in *Alice in Wonderland*, feasted on oysters, we are told the Romans in their banquet halls were praising oysters in poetry. Just as oyster connoisseurs today are prepared to defend the kind of oyster they like best, so the old Romans were divided among themselves as to which were the best oysters—those carried back from Britain by victorious Roman legions, or those from Lake Lucrinus, noted for its famous oysters.

The oyster industry of the United States is one of our few fisheries that has been pursued continuously since early colonial times. It has been the dominating factor in the settlement of many towns, and in the rise of many of them to flourishing communities.

However, and this will make oyster lovers unhappy, yield from the world's greatest oyster ground —Chesapeake Bay—has declined from 111,000,000 pounds to 35,000,000 in fifty years. Even so, Maryland and Virginia still top other states in both quantity and value of output, supplying at least one-third of the nation's domestic production. The entire Middle-Atlantic area yields about 50,000,000 pounds a year, bringing fishermen an income of around $5,000,000 annually. For the country at a whole, oysters rank second only to salmon in value among the harvests of the seas.

Why is the supply of our Atlantic Coast, mineral-rich oysters declining? Dr. Lewis Radcliffe, Director of the Oyster Institute of North America, knows all the answers. This mild-mannered scientist is even busier today than he was back in 1907, when, as "bug hunters" in the Philippines, he and another scientist discovered 125 or more new species of fishes. A veteran of the old Bureau of Fisheries of the Department of Commerce and Labor, he has always been interested in oyster farming and the industry. Besides writing for scientific publications, Dr. Radcliffe is active in several fishery organizations.

Overfishing is one reason for the smaller catches of Atlantic Coast oysters, he told me. Chesapeake Bay oysters, in particular, have been badly exploited. For more than a hundred years its oyster bars and reefs were subject to fishing without any regard for the rate of natural replenishment.

Oysters are interesting from the conservation view-

Mopping up the starfish, enemy of the oysters and oystermen. Here a starfish mop is being hauled up with its catch of these briny predators. The mop is then dipped in a tank of boiling water on the deck. Starfish kill millions of Long Island oysters every year.

point because it is possible to cultivate them like farm crops. About half of the Middle-Atlantic oyster crop comes from public grounds, and half from privately leased and cultivated beds. New York and New Jersey follow the New England practice of developing large private industries. Delaware takes about one-third of its yield from private beds, and Virginia about three-fourths. Maryland, however—producing more oysters than any other state in the country—takes all but a negligible amount from public grounds.

Let us run over the oyster's life history. Oysters grow best in shallow waters. They thrive in enclosed bays, sounds, and river mouths. Here the salinity of the water is lowered by the flow from tributary streams. In Chesapeake and Delaware Bays, and in Long Island Sound, they often grow some distance offshore in water thirty feet deep.

Oysters spawn in summer when the water in which the adult oyster lives reaches a temperature of 65 to 70°F. The eggs are fertilized while floating in the water. Oysters are exceedingly prolific, producing from 15,000,000 to 114,000,000 eggs in one spawning—several hundred million in a season.

When hatched, the newly born young, or larva, is so small that it can barely be seen with the naked eye. At this stage the oyster is free-swimming—bobbing about with the tides and currents—often carried far from its place of birth.

Unfortunately for oyster lovers, infant mortality among oysters is fantastically high. Of the larvae developed from fertilized eggs, comparatively few live long enough to settle down on the bottom at the end of two weeks and attach themselves to clean shells, rocks or other hard objects. Believe it or not—some specimens have been found attached to such things as rubber boots, spectacles, lanterns and tile, all of which had settled to the floor of the sea.

Starfish wrap their arms around oysters when they are attacking them.

You have to watch your language when you trace an oyster's life history. Immediately after attachment young oysters are called "spat." At this stage they are plainly visible to the human eye. Probably not more than two or three percent of the original spat survives, and only a small fraction of one percent of the original spat ever matures!

How would you like it if you had to stay put from early infancy on? Oysters think nothing of it. After its first two weeks of life, the oyster leads a stationary existence. It has a chance of growing, in from three to five years, into a tender, juicy, succulent, marketable oyster from four to six inches long. It is then ready for harvesting.

Strangely enough, an oyster gives away its age by the successive layers making up its shell. Just as each ring in the cross-section of a tree indicates a year's passage of time, so each pronounced layer of shell represents a year's growth.

The oyster has to depend on streams emptying into a larger body of water for its nutrient salts or minerals. Because of its diet, it is a natural source of copper, iron and iodine. Oysters also contain most of the essential vitamins, protein of high nutritive value and glycogen—a substance resembling starch in an easily digested form. That is why oysters are such a healthful food.

"Besides overfishing, another reason for the heavy mortality of Chesapeake Bay oysters is the freshness of the water when heavy rains in Pennsylvania cause floods," Dr. Radcliffe said. The salt content of the oyster's habitat must not be too high nor yet too low—but just right. When floods occur, many oysters die because they cannot live in water that is too fresh.

Dr. R. V. Truitt of the University of Maryland, founder of the Chesapeake Biological Lab-

An oyster dredge operating in Chesapeake Bay. When the shellfish are taken aboard and to the wholesalers, they are graded for size. A three-bushel barrel holds from 500 to 1200 oysters and there are four grades. Once graded, they are then ready for the trade.

oratory at Solomon's Island, Maryland—and an authority on oysters—also stressed this point. "There are two kinds of runoff," he explained. "Ordinarily, an oyster thrives on high runoffs; but excessive runoffs after a severe storm are liable to deal oysters a death blow. Excessive runoffs destroy the salinity of the water; too much fresh water is deadly to an oyster," he added.

Besides minerals, an oyster's bill of fare takes in other items for a balanced diet. The oyster feeds by opening its shell and drawing through its gills a current of water, from which it strains out the microscopic plants and animals. These plants are known to scientists as diatoms, which, with other organisms, are collectively called plankton, and average ten million or so to the quart!

Sometimes a grain of sand or other particle enters the oyster's home. This irritates the oyster. It begins coating the particle with the same substance with which it coats the inside of its shell. The coating process continues until, one day, a pearl is formed.

Dr. Truitt's account of how sunlight, absorbed by diatoms, is transformed into energy by photosynthesis—as in larger plants — makes fascinating listening. Photosynthesis is considered the most important process in Nature. Without it all forms of life would become extinct. Photosynthesis is the original source of every ounce of chemical energy on the earth. It is the process by which chlorophyll—the green pigment in the leaves of plants—utilizes the energy of the sunlight to convert the carbon dioxide in the atmosphere into carbohydrates, or compounds of carbon, hydrogen, and oxygen. The atmospheric oxygen is freed, and the carbon is combined chemically with the hydrogen and oxygen of the water in the leaves of the plant.

An excellent growth of seed oysters on an old oyster shell.

It was a sultry day in August when I talked with the white-clad professor at Solomon's Island. But we forgot the weather as he jotted down chemical equations showing the carbohydrates formed in diatoms through photosynthesis.

Here is a curious fact Dr. Truitt brought out: So small are diatoms in comparison with ordinary plants that proportionately more surface is exposed to sunlight. Naturally anything that comes between them and the sun cuts off their source of energy. That, in turn, lessens an oyster's food supply. And cutting down on light and food makes poor oysters. You will see how this works out as you read further. But for a moment let us go back to an oyster's mineral supply. In Chesapeake Bay these mineral nutrients in solution in the water reach oysters from such streams as the Susquehanna, the Potomac, and the York Rivers. Rivers, of course, get these minerals from the soil.

In early days, runoff from the forest floor was crystal clear. But as our forests were heavily logged, and the land put into agricultural use, the soil in tributary watersheds tended to become less firmly anchored and gradually began to erode.

That is the story of silt entering the waters of Chesapeake Bay. You can see how silt cuts off the supply of sunlight for both diatoms and oysters. Oysters need sunlight, the same as humans. When they do not get enough sunlight, and when diatoms —their staff of life—do not get enough sunlight, a watery grave yawns. That is what soil erosion does to oysters.

The Chesapeake Corporation of Virginia proved conclusively that a principal cause of the declining production of oyster beds at the head of the York River estuary was the muddying over of the river bottom. For oysters grew successfully when they were lifted off the bottom to platforms and raised in wire baskets closer to the surface.

Dr. Truitt is convinced that if proper attention is given to putting more soil and water conservation practices on the land, excessive runoff can be reduced to high runoff—conducive to oyster development—and silt washing into Chesapeake Bay can be lessened in amount.

One thing in the oyster's favor is that Chesapeake Bay waters are blessed by an abundance of nutrients from the vast drainage area of some six or seven states. Another is that much of the Bay is free from many dangerous pests such as starfish and drills, which annually destroy millions of dollars' worth of oysters in adjacent areas.

In November, the third "R" month, it is quite a sight to see oystermen in Chesapeake Bay begin dragging dredges over the bottom and pulling oysters on board their sailing vessels. The dredge is a broad iron scoop, four to six feet wide, with a toothed edge

to dig into the oyster bottom and a chain bag to hold the oysters. After a certain length of time the bag is drawn aboard and emptied on deck.

Tongers get a break because they may start work the first of September of each year. Some grounds are reserved for these men, who use motorboats or rowboats. But tonging is hard labor. The tonger works a pair of rakes, bolted together, that open and close like scissors. He lowers his rakes to the bottom and opens his arms wide to pull the teeth apart. Next he works his arms together by short jerks as the rakes comb through the bottom. When the tongs are opened and closed, the teeth dislodge the oysters, which are caught in the basket formed when the rakes are pulled together. They are then raised to the deck of the boat to be unloaded.

The various states usually stipulate a minimum size for oysters taken from public beds. Once on board the boat, the oysters are culled and those undersized are returned to the water. In Chesapeake Bay those under three inches are shoveled overboard.

At the shucking plant oyster shuckers open the shell deftly with a knife; then the meat is taken out. Oysters are graded as to size and packed into tins, which are immediately iced. The cans go into boxes and barrels with crushed ice and are rushed to market by refrigerated express. The oysters will be fried, scalloped, used for stews, or eaten raw. Many oysters go to market alive in the shell.

You may know that Grand Central Station in New York City is famous for its oyster bar. Here, if you order a stew, you see the oyster shells opened and the stew prepared. It is served piping hot, with a dash of paprika. But the shells are not wasted.

Many tons of oyster shells are returned each year to oyster beds for collecting spat; roads of oyster shells have been built in tidewater areas. Shells are sometimes burned for their lime content, and large quantities are ground for poultry feed.

When an oyster is placed before you, it is relatively safe to assume this succulent son of the sea is in first-class condition. Since 1925 it is rare that any natural shellfish-growing area in the country has escaped close scrutiny on the part of state or federal officials. Probably no other food product in this country is subject to more stringent sanitary regulations than oysters. The various state departments of health make sanitary examinations of oyster beds from which oysters are marketed. The beds must meet certain bacteriological and chemical standards of purity before state authorities issue a certificate to the oyster growers.

But that is not all. As soon as an oyster has been taken from its shell it is again subjected to rigid bacteriological examination. Not only must it meet certain standards of purity, but employees who handle fresh oysters at the shucking plant must pass periodic medical examinations. Also, municipal and state health authorities give the shucking plant and its physical equipment regular examinations.

As further precaution, shippers are supplied a certificate countersigned by the U. S. Public Health Office. This shows that the oysters shipped in interstate commerce conform to the standards of purity. Each shipment is accompanied by a tag showing the name of the dealer and the origin of the oyster. In fact, carriers refuse to accept shipments of oysters not accompanied by such certificates. Another regulation provides for shipping containers described as "non-returnable and non-reusable containers of waxed paper."

What do state conservation officials think about the drop in oyster production? Harold N. Gibbs, administrator of the Division of Fish and Game of the Rhode Island Department of Agriculture and Conservation, has been working on the problem for 14 years. "Years ago we had heavy 'sets' of oysters," he assured me; "whereas we now have successful sets of soft clams, quahogs and scallops.

"No one knows why we haven't had a successful set of oysters here in Rhode Island," he said with a shrug. "For many years all our seed stock has been imported from Connecticut waters."

His next remark, however, threw some light on the matter. "Pollution," he added, "is a major factor, if only from the fact that much of our original setting ground cannot now be leased because the waters are 'uncertified' (to use a polite word) by the Department of Public Health." Oysters have no defense whatever against pollution; once an oyster has "set" it never moves of its own accord.

For many years efforts to obtain from the Legislature a sound program of regulatory control has been the chief concern of the Rhode Island State Division of Fish and Game. Yet some of the laws applying to fish and game have been unchanged on the statute books for forty years, and do not conform to existing conditions. (Continued on page 108)

Sea-Shell Song

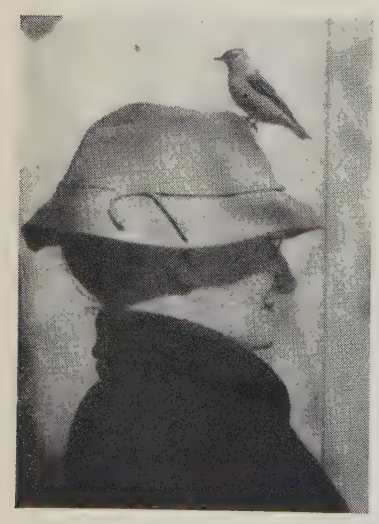
By MARY PEERY WHITTAKER

This empty spiral late from ocean's lair,
Tossed by tide-fingers in an onward swing,
Evokes a song—a bit of sea is there,
Like salt-spray damp upon a curlew's wing.
And with the shell pressed close 'gainst my ear,
Wave-music, eons old, sounds far and low—
The muffled roar—the vastness—does not veer;
And awed by magnitude, I sense . . . I know
Some latent lure from pristine ages gone—
The tug of moon, foam-drench and rolling surge.
The salvaged echoes rumble on . . . and on—
Creation's song with primal cosmic urge . . .
Cupped in my hand from out a lyric sea,
Are timeless tones born of Infinity.

Birds Get in Their Hair

While one chickadee considers taking a peanut, another hovers expectantly.

The chickadee tugs impatiently at a peanut tightly held by Mrs. Lane's teeth.



Mrs. Lane has merely to step on the back porch for adornment for her hat.

IF A bird in the hand is worth two in the bush, what is the value of a dozen of them, scrambling over and contesting all available parts of one's clothing and anatomy? This apparently theoretical question I recently found to be not only factual but also a much enacted experience in the daily lives of two people of my acquaintance.

Sprawled across the western slope of an upstate New York hill lies the unkempt mantle of Sapsucker Woods; set neatly within its depths is a small and modest farm that produces, in addition to its normal yield, one most unusual crop—*birds*. Seldom have there been found so many so constantly in so small an area. Around the year, as season follows season, species come to investigate and remain to be adopted. Tree sparrows and juncos crowd the window feeding station; downy and hairy woodpeckers follow each other up the side of the woodshed, narrowly avoiding collision with a white-breasted nuthatch coming down; chickadees conduct black-capped consultations by the score.

In spring, when white-throats haunt the shrubbery and robins and orioles rule the yard, song sparrows flit along the hedgerows, bobolinks and meadowlarks crisscross the fields, and flickers dominate the orchard. Scarcely have the horned larks gotten their brood upon the wing, than the vesper sparrows take over their nesting grounds. Barely has a catbird begun his diverse serenade, than a red-wing whistles from the audience. Into this environment Arthur C. Lane and his wife have not forced themselves. They created it.

Years ago the Lanes were certain that only one type of home would ever bring them contentment, a small place in the country. It was then they chose their present site, and, in their own words, "Back then, it wasn't much." It consisted mainly of trees and more trees, of thickets and underbrush, of a single cleared field and an aged and ageless cabin of hewn logs chinked with mud. Today that cabin has become a garage, and the farm is a going enterprise, yet much of the latter's natural charm remains, particularly in the case of birds, where it has been enlarged far beyond its original attraction.

At that time the Lanes were not especially interested in birds. Then one winter day, twenty years ago, they grew amused at the fearlessness with which a flock of black-capped chickadees supervised Mr. Lane as he went about his chores. The Lanes decided to test the birds' confidence by trying to lure them into taking food from the hand. Success was assured the moment that one hungry mite seized a morsel, fled, gulped, inventoried himself, found not one tail feather missing, and returned to set an example for his companions.

Later, several nuthatches were drawn into these classes in "hand feeding," and ultimately admission was granted to any feathered hopeful with an appetite, excluding woodpeckers. The woodpeckers quietly retaliated by waiting until Mr. Lane leaned with one hand against the woodshed during a recess period, then unobtrusively sidled over and treated it like a piece of suet. Their complaint was acknowledged.

Since then the Lanes have tamed all manner of birds, but their most accomplished students remain the chickadees. These fluffs of animation are in constant attendance, especially in the winter when native food is scarce. When Mrs. Lane opens the door on a frosty afternoon and imitates their low, plaintive whistle, the sky immediately rains chickadees. From then on, anything can happen and usually does. Incidentally, she has frequent demonstrated that she can call in strange chickadees in an unfamiliar locality as readily as she does those she has trained.

Peanuts provide the great attraction, whether they be offered in the hand, placed on the head, or held in the teeth. This latter act, the most amazing of all, is best staged by Mr. Lane. His mustache furnishes just the proper foothold for the actors. It is not an uncommon sight to see one bird sitting on his chin and tugging at a peanut until the bird's eyes bulge, another hovering in midair and shrilly demanding its turn, and a third conscientiously studying the

By PAUL CHURCHER

Photographs by the Author

required technique from the strategically located vantage of a shoulder.

To the birds, peanuts are peanuts, whatever form they are in. They invaded the first jar of peanut butter, accidentally left uncovered in their presence, with the expected gummy result. However, this was slightly less disastrous than the case of the bird that fell into the can of axle grease. Its squeaks were multiplied a thousandfold, but it never returned for a second lubrication.

Doughnuts, providing they are home made, are also much relished, but, without exception, store pastry is immediately detected and ignored. This compliment to Mrs. Lane's culinary skill has broken her husband of eating between meals, for he has long since grown wary of popping anything into his mouth while out-of-doors, lest he find, too late, that a few-odd chickadees have attached themselves to it.

The worst of Mr. Lane's troubles center around the woodpile. A typical attempt to work in that spot generally goes something like this: From the house to the woodpile, he gropes his way, partly by instinct, through a cloud of chickadees. He spends ten minutes discouraging them from sitting on the chopping block. He reaches for a stick of wood and finds that they have reached it first. He brushes several away and twice as many alight. With great patience he finally gets the stick on the block minus its passengers. "Ah!" he exults, figuratively patting himself on the back. He hitches up his belt, grasps his axe and raises it high. But the blow never falls. Three chickadees have trustingly alighted on the axe head. Ultimately he calls the whole thing off and comes back after dark to do his wood chopping without so much assistance.

As might be surmised, these birds are rather easily photographed, the simplest way being to hold out an empty hand. The birds come readily—and they stay until food appears. Nor can it ever be said that they confine their attention to the Lanes. Dr. Arthur A. Allen, Cornell's Professor of Ornithology, himself found that a professional reputation was no barrier to acquaintances. The first time he stopped at the Lanes, he carelessly smiled while waiting for an answer to his knock. No sooner had his lips parted than the chickadee scout on patrol in that vicinity whistled "Peanuts!" and the blitz was on.

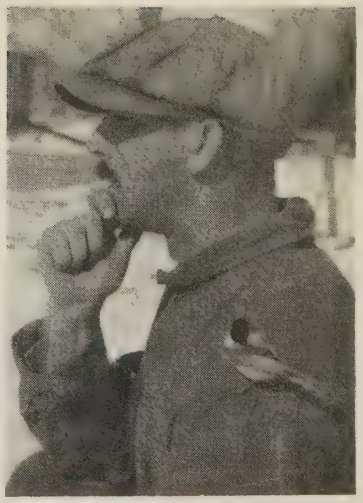
On another occasion, Dr. Allen paused at the Lanes during a hunting trip, and, as a result, his most widely known bird movie resulted. An inquisitive chickadee, the Little Rooster, dropped to his shoulder, hopped the length of his gun barrel, peered long and intently into the muzzle, and apparently made a mental note to give the spot high priority when nesting season came again.

The following spring, when this same bird had taken a mate and set up housekeeping in a less precarious site, Allen nearly disrupted the Little Rooster's happy home. As an experiment, he placed a stuffed chickadee in a flirtatious pose in front of the nest. The Little Rooster's little woman indignantly reduced this rival to little pieces, and for several days threatened to do the same to her lord and master.

Not all of the Lanes' experiences have been restricted to chickadees. One pair of bluebirds has nested in the same birdhouse for ten successive years. A pair of catbirds return to the same corner of the yard every spring, and, before the summer ends, unfailingly produce no less than three sets of offspring. While the female incubates the second set of eggs, the male feeds the vociferous and growing results of the first. Undoubtedly, by the time that autumn comes, the parents not only need a vacation, but also would probably listen attentively to any discourse on birth control.

Occasionally, the Lanes' tenants become so numerous that the problem of congested population arises. Then there is no solution except to send the less desirable families on their way. House wrens, because they destroy the eggs of other birds, are definitely not welcomed; starlings are summarily banished; house sparrows are watched with a disapproving eye.

Another problem is that of predators. Cats, naturally, are conspicuous by



Mr. Lane, in thoughtful mood, has Little Rooster to help in his thinking.

One birdie watches the photographer, another peers over the top of the cap.

The home-made doughnut shows the danger of outdoor eating at the Lanes.

their absence. Crows, hawks (excepting sharpshins), and owls are generally unmolested as long as they remain out in the woods. Gray squirrels are more or less tolerated, but the reds are given a one-way ticket to some other habitat. Chipmunks are not apt to be invited to spend a weekend either, much less move in permanently, although there has been one circumstantial exception that provided interesting drama.

A mother chipmunk slipped into an outlying birdhouse and gave birth to a litter of five before her presence was noticed. The Lanes decided to let them stay until the young were weaned, but one pugnacious nuthatch, who had evidently intended to use the same birdhouse, had different ideas. Each day when the young chipmunks had scrambled to the roof to sun themselves, he swooped ferociously. Although he failed to oust them completely, the frantic attempts of the five youngsters, all trying to escape through one hole at the same time, must have brought him immeasurable satisfaction.

Two youngsters pose in mutual confidence, a neighbor's child and a young nuthatch.

All told, the Lanes have about twenty houses and feeding stations scattered about their yard. Sturdy and natural and carefully spaced, they are protected by the simple expedient of putting them on a post and encircling it with a sharp, slanted strip of slippery tin that discourages invasion.

As might be expected, the care of these houses is reflected in the retention of all possible natural nesting sites. Many a dead and weathered tree has never been reduced to firewood because some hole-nesting bird or other animal has been found using it for a home, or has shown signs of doing so. One tall giant that came crashing down during a storm this past winter proved the worth of this practice. The inner surface of its hollowed walls was scarred and furrowed by the myriad feet that had traversed it, seemingly everything from wild bees to raccoons.

The Lanes are not professional ornithologists, yet they have brought to ornithology those casual and precious contributions without which no profession can long endure. Woven through their interest and enthusiasm, strengthened by years of unplanned observations and records, runs a complete appreciation and understanding of one of the finest gifts that Nature has to offer.

Their informal reports on yearly migration and the like are accepted without question by the most formally trained ornithologist I have known. Their doorstep is forever overrun by the students of this same man, as it is by city bird clubs, by scout troops, and by the children of the countryside. The only price of admission that has ever been asked is, "Will you sign the register?" And that is not price, but privilege, for it contains the names of great and small from all corners of America.

As a matter of fact, these signatures endorse a petition, unwritten, yet irrevocably clear in the minds of many of us, a petition that the world will never lack for such common meeting ground as there is on one small farm out in Sapsucker Woods; that where the veery and the wood thrush serenade the sunset and the ruffed grouse drums in greeting to the dawn, where the goldfinch and the yellow warbler flash like living arrows from the sun by day, and the barred and great horned owls shatter the silence of the forest night, there will always be sanctuary such as that sanctuary now so unfailingly extended by the Lanes—to wildlife and mankind alike; to all who come in friendship.

Meteor Shower

By MARCUS Z. LYTLE

Drift toward the earth and toward strengthening sunlight,
Down from Andromeda's spiral of lace—
Dust of the tattered train of a comet
Stirred by its rush through the highways of space!

Ride the chill tides of remote gravitation,
Dodging a dead star's visionless tomb—
Rust of the shimmering sword of Orion,
After-birth torn from a nebula's womb!

Pour toward the earth in consuming glory,
Freeing the Argo's gold of its dross—
Scales from the shining back of Draco,
Rosary loosed from the Southern Cross!

Illustration by Dorothy P. Lathrop from "Stars To-night" by Sara Teasdale, reproduced by courtesy of The Macmillan Company.

Literary Moonshine

By MARIAN CUMMING

"*Snout:* Doth the moon shine the night we play our play?

"*Bottom:* A calendar, a calendar! Look in the almanac; find out moonshine, find out moonshine."

A Midsummer Night's Dream, Act 3, Scene 1.

THE ADVICE of Nick Bottom should be part of the code of every writer, but if it were my own enjoyment of reading would be lessened, for there is nothing that gives me, an amateur star gazer, such keen pleasure as searching out the astronomical knowledge shown in novels, poems and plays that I read. The discovery that my author's stars have strayed from their paths, or that a moon is topsy turvy in his sky, provokes suppressed chuckles and warms me with that sense of superiority to the great and gifted that may be foolish, but is also enjoyable to everyday folk. Can this author be so omniscient as he would have me think? His errant moon makes lunatic his sweeping statements, and I question whether one who has never raised his eyes to the stars in their courses can plot the course of nations. If he is a poet, his jangling of the "music of the spheres" drowns out, for a moment, the harmony of his verse.

On the other hand I glow with satisfaction when my favorite authors meet the test and prove their astronomical knowledge and careful observation. And there is joy in discovering an author who picks his way safely among the celestial pitfalls. I immediately give him my confidence and esteem.

Although "look in the almanac" is the solution of their problem, many of these authors could have avoided their errors by casual observation. My own knowledge of the sky is gained from a popular astronomy, the astronomy articles in *Nature Magazine,* and a wide Texas sky. So the slips that I notice are elementary. I am not one to whom former positions of the stars are so familiar that I can decide if a planet served as the Bethlehem star, or say with assurance (as I have heard) that there was no "struggling moonbeam's misty light" when Sir John Moore was buried. I am equipped only with an amateur's visual observations and my study of simple astronomy.

Errors about the moon are surprisingly common. The classic mistake, widely known, is that in *The Ancient Mariner:*

"Till clomb above the eastern bar
The horned moon, with one bright star
Within the nether tip."

This is a pretty picture—the thin sickle of the moon as a frame for the gleaming star. We see it in the Turkish flag but never in the sky. The moon does not change its *shape* from crescent to orb. It is always the same great ball. Only the shape of the *lighted portion* changes as it moves in its orbit around the earth. Any star in the position Coleridge describes would be blotted out by the dark bulk of the unlighted part of the moon and we could not see it. Those who watched the beautiful occultation of Venus by the moon in December, 1944, saw this happen. The planet was eclipsed, not "hung within the nether tip."

Coleridge makes a double blunder in the lines quoted above. This mistake occurs so frequently in books that again and again I want to cry to my author, "Look in the almanac, find out moonshine!" or (simpler still) "Use your eyes! Look at the new moon in the evening sky!"

The moon waxes and wanes each month, and we on this earth are pleasantly aware of that fact, but remarkably unobservant of it. We see the moon rise in the east and set in the west. We know that the full

moon rises in the evening and sets in the morning. But the equally obvious fact that the *new* moon rises in the early morning and *sets* in the *early evening* is often unnoticed. A "horned moon" in the evening sky would be always in the west and descending, not climbing the sky. The waning crescent moon may be seen "above the eastern bar" before dawn, but Coleridge's moon rises immediately after "the sun's rim dips."

When I mention this fact to friends they are apt to say, "Are you sure? I'd swear that I have seen a new moon rising in the east in the evening." They have no mental picture of what happens. The crescent moon is largely dark to us because it is on the same side of our sky as the sun, and its bright surface is, of course, facing largely toward the sun and away from us. As the moon's position changes, as its angle away from the sun increases, the light of the sun falls more and more on the moon's surface that we see until, at the full, the moon is the whole width of the sky away from the sun.

The new moon is always setting in the evening—in the western sky, of course—except in polar regions at certain seasons. But so many writers seem unaware of this fact that now, when a new moon appears in a book I am reading, I become at once alert. Will the author avoid these errors? Many an able writer does not. He may be painstaking about other details, carefully correct as to costumes and as to the flora and fauna of his setting. But somewhere in his book a crescent moon shows delicate and lovely, and then, as the night grows late it *climbs* the sky, or the evening is dark until a new moon shows "above the eastern bar." And I gleefully chalk up another score. My author has fallen into the pit of the impossible.

In Pearl Buck's *Sons* there is a lovely scene in the courtyard of the old courtesan. The sons are all home, and, as a courtesy to her, the feast is set in her garden. "And in the center was a small octagonal pool where the little new moon shone reflected." The feast is bountiful and the stories and talk long. Then we read: "Thus the night passed happily and midnight came and the moon swung high, and soft clouds came up and seemed to sway the moon here and there." It seems heartless to point out that this charming picture could never be seen!

Kathleen Norris makes the other error in *Golden Windows:* "Only in the west was color . . .; a new moon rose tremblingly against the clear ultramarine of the eastern sky." Mrs. Norris had just finished getting her heroine engaged and was perhaps weary and caught off guard.

Gwethalyn Graham, in *Earth and High Heaven,* has a new moon rising "where the Adirondacks ought to be," as the family sit at after-dinner coffee in Montreal. The Adirondacks are, of course, east of Montreal, where no properly behaved new moon ought to be in the evening.

Surprisingly, Dorothy Canfield is another sinner. Surprisingly, because she is such a lover of the outdoors, and she gives her errors with such a mass of detail that I think, "Am *I* wrong? *Is* Vermont different?" But in one book, *Seasoned Timber,* she makes several errors about the moon. The "Wall" is a mountain ridge at the east of the valley where so many of her stories occur. On page 245 her professor protagonist, Mr. Hulme, "saw that the new moon, just risen over the Wall, pale as it was, began to dim the stars." On the next page we read that the moon "rose higher, grew brighter and put out more stars." On a camping trip in the same book the professor is waiting for the moon to rise. It is after midnight. "The dark globe spun fast and smooth under the feet of the watchers. The eastern mountains sank. The great disk, white with its heatless fire, swam up to its triumph." A triumph, indeed, for a full moon ("the great disk") to rise after midnight. And a greater one when, before one-thirty, "the moon was high now, straight over his head." From horizon (even a mountain one) to zenith in a little over an hour! Vermont is too far from the Pole to have a full moon rising near midnight and too far from the tropics to have the moon pass straight over the observer's head.

In nice contrast to Coleridge's famous but inaccurate moon is William Cullen Bryant's little known poem, "The New Moon":

"When, as the garish day is done
Heaven burns with the descended sun,
'Tis passing sweet to mark,
Amid the flush of crimson light,
The new moon's modest bow grow bright
As earth and sky grow dark.

Betrayal

By MARY SINTON LEITCH

The darkness breaks! The slow, enchanted moon
Moves from a cloud to silver all the night;
To lay upon the curves of every dune
A glittering coat of burnished malachite,
While warm winds whisper among scented pines
The golden secrets of the jessamines.

So did the wind in Adam's paradise
Stir the leaves softly; so did moonlight burn
Along the slopes of Eden's virgin skies.
Earth gives to us forever vine and fern,
The seas and mountains and, for avatars
Of dream, she gives imperishable stars.

This largest of earth's bounty we betray;
The moon's irradiant treasure is not ours;
From quiet pastures we have gone astray,
And under iron heels crushed out the flowers.
The chalice beauty offers we have thrust
Disdained and broken, down into the dust.

Few are the hearts too cold to feel
A thrill of gladness o'er them steal
When first the wandering eye
Sees faintly in the evening blaze
That glimmering curve of tender rays
Just planted in the sky."

Let us concede that Coleridge's poetry is better, but Bryant's astronomy is correct. He does place his new moon in the west, "amid the flush of crimson light" of "the evening blaze." (Bryant made his own famous "boner" when he wrote of "falling dew", but that is not in our province.)

Even a nursery rhyme can be good astronomy. How many of us have learned to distinguish the crescent of the waning moon, which points west, from that of the waxing moon, which points east, from Christina Rossetti's rhyme for a child:

"O Lady Moon, your horns
point toward the east;
Shine, be increased:
O Lady Moon, your horns
point toward the west;
Wane, be at rest."

(Apparently many illustrators have never learned this rhyme. All too often in their *evening* skies the crescent moon of early morning, with its horns pointing west, appears.)

Among the novelists John Buchan gives a great deal of satisfaction and pleasure to the amateur astronomer by his correct astronomy. The most outstanding example of his accuracy occurs in *The Courts of the Morning*. He certainly must have looked in the almanac when he wrote that book; he must have had an almanac propped beside him as he wrote. For part of the story recounts the adventures of three groups of people over a period of nine days; they meet at the end of that time. Frequently during the action of the story in this period moonrise has a definite relation to the plot and to the movements of the people. Every time John Buchan's moon rises according to the almanac! By his careful workmanship he strengthens the story for any reader; he gives verisimilitude to the strategy of the campaigns and reality to his tale of adventure.

The movement of the constellations is a more difficult test of one's knowledge than the rising and the setting of the moon, but, even so, it is surprising that a book dealing with the life of Galileo, the great astronomer, should err in this respect. *The Stargazer* by Zsolt Harsanyi is so painstakingly written and carefully documented, and goes into Galileo's discoveries and theories so exhaustively, that I did not trust my own judgment. I checked with a planetarium to see if I were right in saying that in this paragraph he pictures the impossible in one detail:

The time is summer, 1624; the place, Florence. Galileo "glanced with trained eye toward the seven stars of the Great Bear. He followed the prolongation of the line of the stars and saw shining Arcturus. Then, turning his head slowly to the right, he named to himself the Serpent, Hercules, Vega, the Swan, threw back his head to look at Ursa Minor, and, in the midst of heaven, the Stella Polaris. Then he turned round and his eyes caught the radiance of Orion above the horizon."

I was relieved to find that I was right. Boötes (which contains Arcturus) and the last tip of Orion would have been visible up to the first of June. But, a few pages earlier, we read of Galileo's return to Florence from Rome, bearing a Papal letter dated June 8, 1624. Even Galileo's "trained eye" could not have seen Orion and Arcturus on those summer nights in the sky above Florence.

Dorothy Canfield's Professor Hulme of *Seasoned Timber*, on that same night (it must have been quite a night!) when he saw the full moon rise after midnight later "flung back his head to draw in a great gulp of the soft June air. His eyes were caught by the position of Orion. It had shifted perceptibly since he last looked up. With just that slow, implacable shift his star had sunk lower." Even by the first of June Orion sets in the very early evening, so, if the comparison is valid, the professor's star was not sinking; it had long set.

Where more pretentious authors have failed in their handling of the stars Jane Austen is quietly accurate. In *Mansfield Park* Fannie Price and her Edmund have a little conversation on the advisability of "a taste for Nature in early life." Then Edmund says,

"There's Arcturus looking very bright."

"Yes, and the Bear. I wish I could see Cassiopeia."

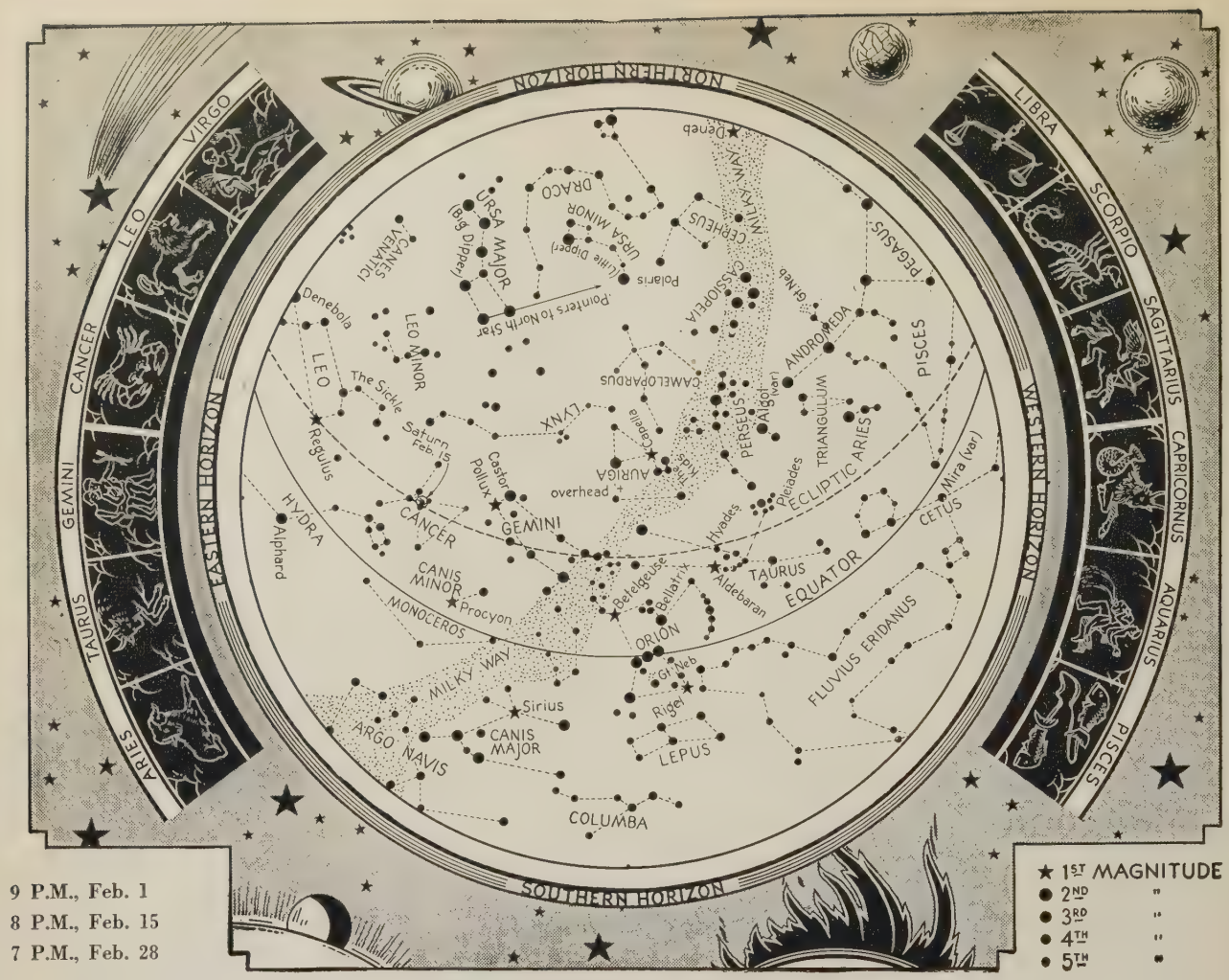
"We must go out on the lawn for that. Should you be afraid?" asks the Georgian gentleman. For once, Fanny was not afraid but the brilliant Miss Crawford lured her Edmund away. There was no more star-gazing for her that night.

This incident takes place on an August night; we know, because we have been told that Sir Thomas is expected home "in three months, in November." In August Cassiopeia would be high in the heavens, above and behind the house, when Arcturus was visible in front (Continued on page 103)

Story under the Stars

By COSETTE MIDDLETON

They both were members of the faculty:
She taught Domestic Science year around;
He was Professor of Astronomy,
Cum laude and degreed to the profound.
They rendezvoused beneath the frosted stars;
She struggled to demand his eyes, his lips
While he discussed the atmosphere on Mars,
Conjectured on the moon's coming eclipse.
He dropped her hand to point out Pleiades,
Leaped to his feet to hail a meteor;
He watched Orion shoulder Betelguese—
She nodded gently and began to snore.
A zero minus to her heart's vain tally!
Next week she weds a miner from the valley.



To use this map hold it before you in a vertical position and turn it until the direction of the compass that you wish to face is at the bottom. Then, below the center of the map, which is the point overhead, will be seen the constellations visible in that part of the heavens. It will not be necessary to turn the map if the direction faced is south.

Magnificent Orion

By ISABEL M. LEWIS

No constellation surpasses Orion, The Warrior, in splendor. Scorpio, Centaurus, and the huge constellation of Argo Navis, which has been broken up into minor groups representing various parts of the ship, Argo, are indeed great constellations, but they do not have the advantage that Orion possesses—a central position astride the celestial equator, from which he is visible all over the world. Neither do they possess the commanding appearance of this great celestial celebrity. The huge quadrangle, its four corners marked by four brilliant stars, two of them super-giants; the great Belt of Orion at the center formed of three stars of second magnitude, evenly spaced in a line three degrees in length; the Sword Scabbard depended from the Belt, in the middle of which, faintly visible even without telescopic aid, is the Great Orion Nebula—all these are features of this great constellation. They combine to make it one of the most magnificent objects in the heavens.

Betelgeuse, the red, variable, super-giant star, which has a range of brightness between that of near-by Procyon and Aldebaran, is not a true member of the Orion group. Most of the Orion stars are of the same type. They are the helium, or B-type, stars, so prevalent in this constellation that the word Orion-type is also used to designate the type. They can be recognized easily by their bluish-white color, which is an indication of their excessively high temperature. Betelgeuse shows by its color alone that it is not one of the helium or Orion-type stars. It is at a distance of about 270 light years from the earth. The Great Orion Nebula and the stars embedded in it are approximately 1000 light years distant. Betelgeuse is noted for the fact that it was the first star whose di-

ameter was measured some few years ago by means of the interferometer. It was found that the diameter of Betelgeuse was about 240,000,000 miles. The star of greatest known diameter was later found to be Antares, which has a diameter of about 400,000,000 miles.

The name Betelgeuse means "Armpit of the Central One," and is an Arabic word. There are several different spellings, among which are Betelgeuze and Betelgeux. The star marks the right shoulder of Orion, and the line of faint stars running in a northerly direction towards the horns of Taurus are supposed to represent the unsheathed Sword of Orion, with which he faces Taurus the Bull. The second magnitude star at the northwest corner of the quadrangle bears the name of Bellatrix, which means Amazon or Female Warrior, and it marks the left shoulder of Orion. A long line of faint stars curving upward from a point to the southwest of Bellatrix represents—as drawn on ancient charts showing the mythological figures of the constellations—the upraised left arm of Orion over which is draped a lion's skin. The group of three faint stars midway above a line connecting the two stars in the shoulders are in the head of Orion. Rigel, at the southwest corner of the quadrangle, marks the left foot of Orion, and Saiph, at the southeast corner, a second magnitude star, the right knee. The Warrior stands with his back to us and is turned toward Taurus, the face seen in profile. A continuation in a southeasterly direction of the line of three stars in the Belt of Orion leads to Sirius, in Canis Major.

Rigel is intrinsically one of the brightest stars in the heavens. Among the stars of greatest *apparent* brightness it is surpassed in this respect only by Canopus, and Deneb in Cygnus. If these stars were distant from the earth 33 light years, at which distance the sun would appear as a faint fifth magnitude star, Rigel would be 1½ magnitudes and Canopus and Deneb almost exactly 3 magnitudes more brilliant than Venus, one magnitude representing a change of about 2½ times in brightness. The distance of Rigel from the earth is about 500 light years.

In the center of the Sword of Orion, which extends southward beneath the lowest star in the Belt, lies the luminous patch, faintly visible to the unaided eye, which appears even in small telescopes as an object of exceptional beauty and splendor—the Great Orion Nebula.

The great, diffuse, gaseous nebulae, of which the Great Orion Nebula is one of the finest examples, are characterized by irregular and even chaotic form, enormous variation in apparent luminosity, and extreme tenuity, even to the point of almost vanishing density. Moreover, nearly all gaseous nebulae are associated with stars that are believed to be the source of their luminosity. The nebula absorbs and re-emits radiations from the involved stars. If the spectrum of the nebula shows bright lines, which are now known to belong not to some unknown element "nebulium" but to highly ionized oxygen and nitrogen, the involved stars are always the extremely hot early-type, or helium, stars. If the nebular spectrum shows no bright lines, but is continuous, the involved stars are later-type stars. The Trapezium area, as it is called, in the center of the Great Orion Nebula, is formed by four stars of 6, 7, 7½, and 8 magnitudes, which, with two others that can be glimpsed with a 3-inch telescope, form the sextuple star, Theta.

The brilliantly luminous region of the Great Nebula, in which this star is embedded, is estimated to have an extent of about ten light years, and to contain about a thousand cubic light years. Yet this region is but a pygmy in size compared with the enormous diffuse nebulosity that involves most of the central portion of this great constellation looped around the Sword of Orion, and most of the region surrounding the Belt. At the distance adopted, 1000 light years, its extent can scarcely be less than 100 light years. Unless the density of the nebula were almost vanishingly small, its mass would be so great as to sway by its gravitational effects the motions of all celestial objects in this part of the Galaxy. Nebulae, both light and dark, are clearly observable in the vicinity of many of the Orion stars. A remarkable region of both luminous and nonluminous nebulosity exists south of the star Zeta, the lowest star in the Belt. Here are five bright, diffuse nebulae and the remarkable dark area known as the Bay, or Horsehead Nebula. Four nebulous stars exist in the same region. A remarkable feature, also, is the great difference in the number of faint stars visible on opposite sides of a line passing nearly due north and south through the star Zeta. It is as if there existed a dense, dark mass on the east and a much thinner luminosity on the west sufficiently transparent to transmit the light of stars lying beyond, while the dark, dense nebulosity to the east blots out the light of stars behind it. North of the star Zeta is evidently a continuation of this nebulous region. A nebulous area 12½ degrees in extent also lies to the south and west of Rigel, which, at the distance of this star from the earth—nearly 500 light years—corresponds to a distance of 100 light years.

Directly below the Great Nebula is the triple star of 3½ magnitude, Iota, somewhat fuzzy in appearance because it also is involved in a nebulous region. The entire constellation of Orion is characterized by an exceptionally large number of double and multiple stars; that is, two or more physically connected stars, which are excessively hot and frequently embedded in diffuse gaseous luminosity.

The best time of year to observe this beautiful constellation is in the winter of the northern hemisphere and the summer of the southern hemisphere, preferably, we would say, in February and early in March. Then it is near or on the meridian in the early evening hours, the time when (Continued on page 106)

The School Page

Edited by E. LAURENCE PALMER

Professor of Rural Education, Cornell University, and Director of Nature Education, The American Nature Association

LIVERWORTS, MOSSES AND CLUB MOSSES IN SCHOOL

WHILE most field naturalists enjoy best finding and studying Nature in the field, no one can deny that much may be learned by bringing specimens indoors. This applies to the plants dealt with in this month's special insert, and to many of the other groups that have been similarly treated. The results of indoor study will depend considerably on the interests of the collector.

Those who like to continue seeing things alive and growing, even in an unnatural environment, will have little trouble in making grow some of the plants here considered. They will have much difficulty with others, and will probably fail completely with still others. An unused terrarium, or a fish globe, or even a few wide-mouthed glass jars will provide suitable temporary homes for some of these plants. Usually particular care should be taken to avoid changing drastically the nature of the water and soil available to the plants in their new environment. Do not take a plant from some limestone and plant it in a soil richly fertilized with manure, or of the acid type, and expect it to prosper at all times. Similarly, do not put limestone rocks in your terrarium for effect, and try to grow on them plants that favor an acid soil. They will not live, and you will not be pleased.

In most cases we have indicated in the chart section the soil preferences of the individual species mentioned. Consider these carefully, particularly if you found it impossible to bring to the terrarium some of the materials on which the plants originally grew.

Dry Air Fatal

Plants brought indoors commonly do not survive because of the excessive dryness of the air in which we seem to find comfort. This, of course, can be remedied by covering the container with a piece of glass so that the air remains humid inside. If the unit is not too crowded, the plants may thrive with little, if any, attention once they have become established.

One interesting thing that can be done with mosses indoors is to maintain a few plants of a clump in an enclosed terrarium, and to try to maintain another portion of the same clump in the schoolroom air. Many mosses have obvious means of indicating that they are not doing well in the dry air. What are these? If you do not know, then try it and find out for yourself.

Many persons like the appearance of some of the more attractive club mosses, and try to grow them indoors in terraria. This is only rarely a successful experiment. These plants usually are dependent on a long underground structure that can not easily be transplanted.

Many persons who transplant mosses, liverworts and their kin indoors overlook the fact that, in Nature, these plants may have grown best in the shade. People try to make shade-lovers succeed in terraria placed in a bright window opening. As a rule shade is more likely to be suitable for these plants than sunlight.

Heat may also be a factor that is overlooked in trying to grow plants indoors. Only yesterday I visited a schoolroom where a terrarium had been placed directly over an active radiator. Life in that terrarium had long since vanished.

People also have the idea that plants in terraria need constant care and watering. If the unit is properly managed the addition of water may be necessary only at considerable intervals. If the tap water available is "hard" it would be well not to use it on plants that you found growing on "sour" soils. Rather, you should use a little rainwater in cases of this sort.

Some will read about the reproduction of some of the plants mentioned and may wish to see how the spores develop. Germinated spores may usually be seen to develop with the commoner mosses if the spores are sprinkled with some dilute Knop's solution. To make this solution you add to 1000 c.c. of distilled water one gram of potassium phosphate, one of magnesium sulfate, one of potassium nitrate, and three of calcium nitrate. This solution should be diluted about one-third, and spores may be expected to develop within about one month.

If you live in a region where the spores of any of these plants may be collected in large quantities you will enjoy experimenting with them to see how much water a gram of them can absorb; how inflammable a *small* quantity may be; whether they would be likely to stick to the wet fur of passing animals; whether you can make them grow in total darkness; at what temperatures they seem to grow best, and so on. If you do not care to prepare elaborate culture media you may have success by merely sprinkling some spores on some sand that can be kept wet for a few weeks, and then exploring the sand to find the threads that indicate growth.

Hints to Collectors

If you are a collector and feel that you must have samples that represent all the different kinds of these plants you have been able to find, a few hints may be useful.

Ordinarily bryologists do not mount their specimens on large sheets, as do those who collect the higher plants. Instead, they usually store them away in small envelopes (sometimes of cellophane), or in pieces of paper folded into triangles in which the small specimens may be filed. Little treatment is usually necessary for dry herbarium material. Other collectors may prefer to preserve their finds in some liquid, since the plants are more likely to have a natural appearance under these circumstances than when they have been dried.

Alcohol or formalin may be used as an emergency preservative, but these fixatives frequently create an effect similar to drying, since they, too, remove the water from the plants. They may also remove much of the distinctive coloring matter. If one wishes to keep plants in as lifelike a condition as possible the following procedure is suggested.

To 90 c.c. of 50% alcohol add 5 c.c. of commercial formalin and 5 c.c. of glacial acetic acid. Put plants in this material.

If these materials are not available, procure a few crystals of copper sulphate, dissolve them in water and use this as a preservative. Ordinarily, this is not recommended because of the poisonous properties of the copper sulphate. Surely it should *not* be used in schools, where there is danger that children might be tempted to taste the liquid. It is true that the other fixatives suggested cannot be taken internally with safety, but they are not likely to have such serious consequences as would the copper sulphate.

In spite of the fact that it may be contrary to some school procedures, this page holds that unless the school gives the pupil the desire to see and know a thing in its natural setting the point of the study has been badly missed. This holds for this group of plants as well as for other subjects that have been covered in these special inserts. If you or your pupils can pass a mass of spore-bearing horsetails, club mosses or their kin and not get down and jar their spores loose; if you cannot in your imagination picture some of these plants magnified many times to approximate the size of their Carboniferous Period ancestors; if you cannot see cannel coal as the last remains of a great mass of the spores of similar plants; if you cannot get down on your knees or tummy and squeeze the antheridia from a moss antheridiophore; if you do not crush some conocephalum between your fingers to get the resinous odor that will cling there for a long while, then you have only begun to explore the possibilities these plants offer you.

LITERARY MOONSHINE

(Continued from page 99)

of it. Miss Austen had brothers in the Navy; starwise themselves, they may have taught their sister much about the constellations and their relative positions. But, knowing Miss Austen's keen and accurate observation of human characters, and remembering Sir Walter Scott's tribute to "the truth of her description," I am not surprised to find that she is correct in her observation of predictable bodies as well as unpredictable ones.

Some may think that poets who "dwell among the stars" do not know them as astronomical facts but as the stuff of dreams only. I have enjoyed adding to my collection examples from poets whose knowledge and poetic vision are equally sure.

Here is Sara Teasdale, a great lover of stars, who has often celebrated them in her verse. Her "Rhyme of November Stars" is a joyous rosary of their names:

"Vega, Deneb, white Altair
Shine like crystals in the air,
And the lonely Fomalhaut
In the dark south paces low.
Now the timid Pleiades
Leave the shelter of the trees,
While, toward the north, mounting high,
Gold Capella, like a queen,
Watches over her demesne,
Stretching toward the kingly one,
Dusky dark Aldebaran.
Betelguese and Rigel burn
In their wide wheel, slow to turn,
And in the sharp November frost
Bright Sirius, with his blue light,
Completes the loveliness of night."

Her listing of the winter stars is correct, in contrast to the incorrect list of summer stars in Harsanyi's *The Stargazer*, and she conveys the jewel-like brilliancy of a frosty night. This quotation, from Robert Baker's astronomy, *When the Stars Come Out*, verifies her observation of the colors of these stars: "There are fine color contrasts among the stars in the winter sky. Betelguese is red, Rigel, diagonally across the oblong figure of Orion, is blue, and Sirius is a blue star also. Capella up in Auriga is yellow like the sun. Aldebaran, in the V-shaped Hyades, is a redder yellow."

In her poem, "Winter Stars," Miss Teasdale sees

"Orion in the east
Burn steadily, as long ago"

and so, in a wartime winter, finds comfort in "the faithful beauty of the stars." "To Arcturus Returning" celebrates the star she loves best:

"your recurrent burning
Is spring's most punctual miracle."

As Arcturus is the sign of the return of spring, so the constellation Orion ushers in the winter season. It rises in the evening sky, as Miss Teasdale has shown, in November, and is visible until April. It first appears in the morning sky in August. In "Thurso's Landing" Robinson Jeffers gives a sense of strangeness by stars, familiar to us in the spring, seen at dawn in autumn:

"Orion and Sirius
Stood southward in mid-heaven, and Armstrong said,
'They're strange at dawn, see, they're not autumn stars.
'They belong to last March.' 'Maybe next March,' she said."

This is a random collection of authors sure or faltering in their knowledge of the sky. New ones are constantly appearing, and it is interesting to watch for them. While one may be critical of their errors, and warmly approving of happy examples, one must admit that there is no direct connection between astronomical knowledge and literary excellence. Comic strip artists do draw a waning moon with horns pointing to the west to denote early morning; on the other hand the Great Bard himself is not infallible.

On rereading *Midsummer Night's Dream* I have found that Shakespeare, who put such wise words into the mouth of his clown, made his own errors in the same play. There is a curious mixture of accuracy and inaccuracy. When Bottom asks: "Does the moon shine the night we play our play?" Quince answers: "Yes, it does shine that night," although they are rehearsing in the wood and no almanac would have been at hand. The play is given to celebrate the wedding of Theseus, which is already set for the night of the new moon (Act I. Sc.1). The players must have figured that the first night of the new moon would not give enough light and so they use the comic character with lantern and faggots to represent the Moon. So much is good sense. But most of the action occurs in a single night, two nights before the wedding (or one night, because the Bard also carelessly misplaces a day) and all through that night there are references to moonlight. Quince says they will rehearse by moonlight; Oberon greets Titania with "Ill met by moonlight"; Titania orders the fairies attendant on Bottom to "fan the moonbeams from his sleeping eyes", and later says: "The moon, methinks, looks with a wat'ry eye", and there are other instances of moonlight in the dark of the moon! And I had used Shakespeare as spokesman in my plea for astronomically accurate authors! Of course the answer is that anything can happen in a wood outside Athens when fairies take over, and that when a great master adds his spell to theirs nothing else matters.

But to all lesser authors I still insist, "Look in the almanac, find out moonshine."

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Camera Trails

By EDNA and BILL EVANS

We do not go in for what are known as the "spectator type" sports. In other words, we do not like to sit and watch the other fellow play and have fun. We want to do it, too. For that reason we fail to get much of a "kick" out of football, basketball, baseball, the derby or any of the other classics of the spectator-sports world.

Hunting is definitely out because we do not like to kill things. Fishing is all right, within limitations—the limitations being that the fisherman catches what he can use and calls it a day. Fishing expeditions that depend for their success on astronomical numbers or record-breaking poundage do not interest us, either.

Maybe we have ingrown personalities. Maybe we are introverts of the extremest kind. Maybe we are definitely anti-social. Be that as it may, we have our definite likes and dislikes.

Perhaps all this explains why we are so fond of Nature photography. That is pretty much of a lone wolf's job—no crowds to cheer, no bands to play, no multitudes to rub shoulders with. Nor is there a person like a coach, trainer, pro or guide breathing down our necks all the time and telling us what to do.

To our way of thinking, Nature photography is something each fellow has to work out pretty much for himself. Of course, there are certain definite things to be done, certain techniques to be mastered, and a few specific rules to be followed. But there is not any one certain way to hold your elbows, no particular way you have to stand. You just do the best you can, learn from your own mistakes, keep on trying until you get what you want—or else quit and find another hobby.

Some hobbyists collect vast libraries of information concerning their particular interest. Others read everything they can find about how to be a better Pogo-stick jumper, parchesi player, or yo-yo twirler. Personally, we doubt that anybody ever learned to swim by reading a book about it. But we will admit that printed material (within limits) will be of some value.

There are plenty of how-to-do-it books on photography. There are quite a few magazines, too. Some of them use a lot of words without getting much said. Others are too dull and technical for the average happy-go-lucky layman. Some few, however, really are helpful.

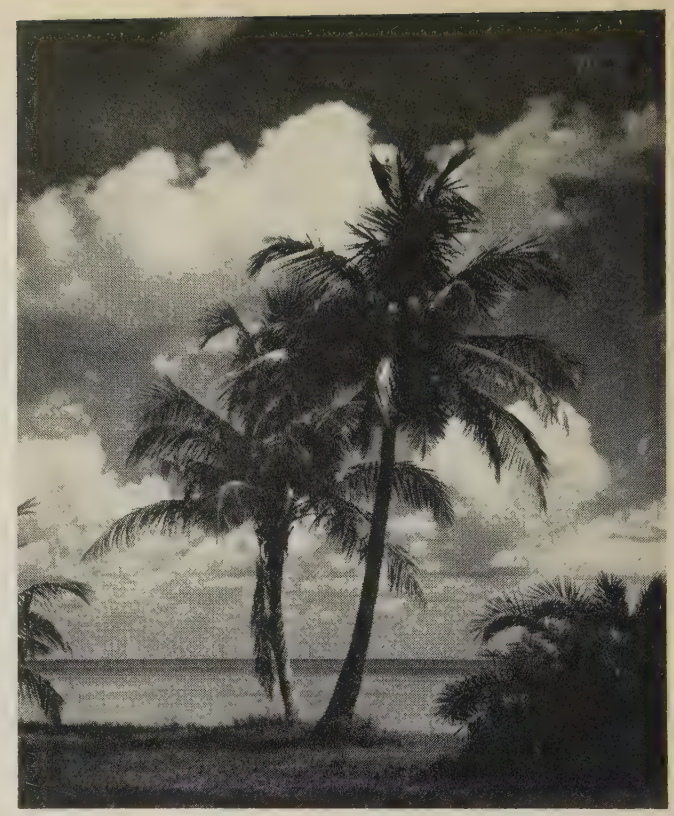
Picture albums, like the *U. S. Camera Annual,* are quite helpful if studied with an eye to improving one's own technique. Maybe the actual data concerning exposure, timing and so forth will not be of too much use. But the picture itself can tell a lot.

The Nature photographer too often thinks in terms of big areas—landscapes, with a lake, a couple of mountains and a forest or two all mixed in together. Or he is concentrating so sharply on one bird, a nestful of hungry fledglings, or an animal—whether it be a bear or a bunny—that he forgets everything else.

There are a lot of beautiful designs in Nature, designs that are apt to go unnoticed unless the photographer watches for them especially. It is easy to see the photogenic possibilities of a couple of well-placed trees, plus a gorgeous cloud background—but did you notice the pattern made by those fern leaves? You can see the beauty of a sailboat—but did you notice the wind-ripple marks on the patch of white beach sand, or the rabbit tracks across the snow?

When you look over a collection of pictures and note what the other fellow has found in Nature, you are apt to find yourself seeing more things, too.

The pictures used to illustrate this section show what we mean. We are very proud of our palm tree picture—taken with a deep red filter to bring out the clouds. But almost anyone with half an eye for photography could have seen the picture there. On the other hand, the mushroom picture, taken by R. L. Coffin of North Amherst, Mass., and exhibited in the Nature division of the 1946 exhibition of photography of the Photographic Society of America, shows a beauty of design that not everybody would notice.



We are proud of this palm tree picture, taken with a deep red filter to bring out the clouds, but we admit that anyone with half an eye for photography could have seen a "picture" here.

Thus, for the inspiration it may give and the ideas it may engender, we think that every camera enthusiast should have some sort of library. It does not have to be a large one. But it should be a source of new ideas, and it should give some help in solving knotty problems.

INFRARED PHOTOGRAPHY

We recently received a new book, *Photography by Infrared,* written by Walter Clark and published by John Wiley & Sons, Inc. It is a second edition, copyrighted in 1946. Plates for the first edition, copyrighted in England in 1939, were destroyed during the air raids on London. The new edition has been revised to include discoveries and advancements made during the war. Entirely new material, on camouflage detection by infrared and on forest survey from the air, has been added.

The book is much too technical for the average amateur camera fan, and parts of it require a firm foundation in physics for complete understanding, but it does contain a great deal of interesting material.

Many almost supernatural powers have been ascribed to infrared photography, and, for that reason, this quotation from page 314 struck us as especially apt:

"Among the most fantastic claims which have been made for infrared photography is its alleged ability to penetrate dense fogs, thereby allowing ships to navigate with complete safety in the worst weather and airplanes to land when the ceiling is zero. It is largely through claims of this kind that the public's imagination was played upon in the popular press. The impression created still lingers, and so it is appropriate at this point to emphasize most emphatically that, according to both theory and practice, such claims are utterly without foundation. Although

This mushroom picture, taken by R. L. Coffin of North Amherst, Massachusetts, shows a beauty of design that not everyone would notice. "Seeing" pictures is quite as important as taking them.

infrared is immensely valuable in penetrating atmospheric haze, the chances of penetration decrease as the haze thickens into mist and the mist into fog. When a fog is dense enough to be a menace to navigation, it is impossible to increase visibility through it by means of infrared photography. Moreover, there seems to be no chance of doing it in the future, whatever strides research may make in infrared plates and films."

Of special interest to readers with a leaning toward the natural sciences are the chapters on the uses of infrared in connection with medicine, botany, paleontology, photomicrography, astronomy and forestry, as well as in connection with landscape photography.

So far as equipment is concerned, Author Clark points out on page 11 that, "Anyone equipped for photography with ordinary, orthochromatic, or panchromatic plates or films can make infrared photographs without investing in any extra equipment other than a filter for use on the lens of his camera." But it would be well to do some research before setting out to take infrared photographs.

EASTMAN BOOKLETS

Eastman issues, from time to time, Kodak data books on various subjects. Some of the more recent ones deal with *Slides, Formulas and Processing* and *Kodak Papers*. Each book sells for twenty-five cents. Eastman also issues numerous pamphlets on special photography topics, made in uniform size and punched to fit in the binder of a photographic notebook. Copies of these pamphlets may be obtained, without charge, by means of a card or letter sent to the Sales Service Division, Eastman Kodak Company, Rochester 4, N. Y.

Along this same line is the Little Technical Library, published by the Ziff-Davis Company of Chicago. This series includes some thirty volumes, priced at ninety-five cents per book, on assorted photographic subjects. Of special interest to Nature photographers are the volumes on *Outdoor Photography, Filters and Their Uses* and *Manual of Correct Exposure*. Some are more technical than others. Some are quite readable and others will put you to sleep—it depends largely on how interested you are and how much you know of what you are reading about.

The Kalart Company has recently released the second of its "how to do it" booklets, entitled *How to Take Synchro-Sunlight Pictures*. This follows another telling how to take speed flash pictures of the baby. Both sell for ten cents, but, for a limited time, the sunlight one is offered free to "Camera Trails" readers. Mention Nature Magazine and write directly to The Kalart Company, Inc., Dept. 91E, Stamford, Conn., for your free copy.

PHOTO CONTEST

If you are interested in contests (and who is not?) take note of the third annual Dassonville Print Competition. The 1947 contest is open to photographers all over the world. Closing date is April 1. A special trophy will go to the winning Camera Club, and cash prizes of more than $1500 are offered. For entry forms and a complete copy of rules, write to Dassonville Company, Ltd., 205 East 42nd Street, New York 17, N. Y.

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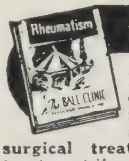

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THE ROSICRUCIANS
SAN JOSE, CALIFORNIA

THE CASTLEBUILDER

(Continued from page 72)

ment of the young, it was necessary to open the same nest repeatedly in this manner. After each examination, I pressed together the sticks I had parted and stuck additional pieces into the gap that always remained, but I was never able to obliterate entirely the evidence of my intrusion. The owners, on returning to the nest, would notice the alteration almost at once and fetch fine twigs to stuff into the chinks I had left, continuing this until one could not tell that the wall had been broken. The point where the breach had been made would occupy their attention for several days, and seemed to worry the birds even after it had been, to my eyes, perfectly mended. The birds often stuffed green leaves and fragments of reptile skin, which ordinarily were applied to other uses, between the twigs in the position of the break.

One day I purposely left a fair-sized gap in the side wall of a nest that sheltered two nestlings. The moment I moved away, one of the parents, who had been fidgeting around at a little distance, flew up bearing a stick, which it thrust into the breach. Then it continued with great industry to bring twig after twig to the gap, flying down again and again to recover those that had fallen beneath the nest, rather than go off to a distance for them. Meanwhile, the mate brought an insect to the hungry nestlings. Their domestic organization was perfect; neither bird was in the least flustered by my attempt at housebreaking, and neither uttered a sound. Each knew perfectly, without mutual consultation, what the situation required. When dusk was deepening into night, I returned and found one of the birds still working little twigs into the nearly obliterated gap, while the mate busied itself with arranging the sticks on the platform.

As nearly as I could determine, without unduly disturbing the routine of the nest by too frequent visits of inspection, the eggs must be incubated seventeen or eighteen days before they hatch. The newborn nestlings, typical passerine bird babies, are blind and helpless. Their light skin bears a scant, dusky down on the head, back and wings. The inside of their mouths is yellow. Both parents brood these nestlings and bring them small spiders, small insects and green caterpillars. Even the necessity of providing for four hungry mouths does not cause the adults to neglect their nest, and they still find time to keep it in good order, repair damages, and bring additional twigs. They make neither vocal protest nor feint of attack when their little ones are removed from the nest in their presence, doubtless because such demonstrations would be of little avail in the face of an enemy powerful enough to tear open their castle. They continue calmly to feed their nestlings while a man watches them, unconcealed and only a few feet distant.

One might surmise that the nestling castlebuilders, growing up in the inner keep of a castle so cunningly designed and strongly constructed, would be exempt from the perils that exact so large a toll of young birds of most other kinds. But let a bird place her eggs where she will, swinging in a woven basket from the tip of a slender twig a hundred feet in the air, in a hole in the heart of a tree-trunk, buried beneath the ground, or in an intricately designed castle entered by a narrow passageway, there is ever some enemy that will discover her secret. The castlebuilders are not exempt from the heavy toll levied upon eggs and nestlings; and their nests are robbed with surprising frequency by some small, slender creatures, snakes or lizards or perhaps small rodents, which enter through the tunnel and take the eggs or young without making a breach in the wall. As with nests of other kinds, any interference by human beings, no matter how slight or how well intentioned, seems to increase their liability to destruction. Of the many that I watched, only in a single instance did the parents succeed in bringing forth a nestling into the world. As I opened the back of the chamber to look in, the young castlebuilder fled down the tunnel and escaped through the doorway. Then, fluttering to the ground, it hopped away through the short grass so rapidly that I succeeded in capturing it only after it had led me a merry chase for twenty feet. Fourteen or fifteen days of age, it was already well feathered, but differed from its parents in its tawny rather than rufous breast, and its brown instead of red eyes.

The structures that the castlebuilders erect with so much labor serve only for the one, or sometimes two, broods they rear in a single season. Once abandoned by their builders, the nests are often occupied by large, black ants, which swarm out in incredible numbers when the supporting branch is rudely shaken. If they escape the ants, termites may claim them and build a network of tunnels over and through them. Even should they remain free of these insect invaders, they are so weakened by decay during the long wet season that they are unfit for use a second year; and the hard-working castlebuilders must each spring build their nests afresh.

MAGNIFICENT ORION

(Continued from page 101

most of us prefer to do our star gazing. Early in May it disappears in the rays of the setting sun, appearing next in the early morning hours in late summer, and rising around midnight in November. At the equator Orion rises due east, passes directly overhead, and sets due west. In the southern hemisphere he appears in inverted position, head toward the northern horizon, feet directed upward. At the North Pole only the northern half of the constellation is visible, and at the South Pole only the southern half.

Mercury will be found in the evening sky in February, and at time of greatest eastern elongation on February 20 will be only about 10 degrees above the southwestern horizon at sunset. Venus is approaching the sun in the morning sky, and by the end of the month will be only 15 degrees above the southeastern horizon at sunrise. In the telescope it will be seen to be in the gibbous phase. Mars is now too close to the sun for observation. Jupiter will be in quadrature with the sun on February 15, when it will be on the meridian at sunrise. It is in the constellation of Libra, and will be in close conjunction with the moon on the night of February 12-13. Saturn is in Cancer, high in the east at sunset, and visible for the greater part of the night.

Yale Collections

The Yale Collections. By Wilmarth S. Lewis. New Haven, Connecticut. 1946. Yale University Press. 54 pages. Illustrated. $2.00.

This is a short survey of the collections of books, manuscripts, objects of art, natural history and anthropology, that have come to Yale during the past two and one-half centuries. The author briefly describes some of the most striking of these collections. In its entirety this material is rivalled by only three other universities in the English-speaking world.

Rocky Mountain Park

Raymond Gregg, Park Naturalist at Rocky Mountain National Park, is the author of an attractive and concise descriptive guide to the Park published by the Rocky Mountain Nature Association at twenty-five cents. This sixteen-page bulletin will be of particular value and interest to visitors to the Park, past and future.

ANSWERS TO WINGED COLOR QUIZ

1-r, Bronzed grackle; 2-n, Snowy owl; 3-h, Indigo bunting; 4-q, Golden plover; 5-j, Ruddy duck; 6-t, Sooty shearwater; 7-a, Rusty blackbird; 8-l, Scarlet tanager; 9-p, Brown creeper; 10-b, Yellow rail; 11-f, White pelican; 12-o, Blue jay; 13-s, Green heron; 14-e, Roseate spoonbill; 15-c, Slate-colored junco; 16-k, Purple finch; 7-d, Olive-sided flycatcher; 18-i, Cerulean warbler; 19-m, Cinnamon teal; 20-g, Red phalarope.

THE READER'S MARKET

A place where members of the American Nature Association and readers of Nature Magazine may find many interesting offerings, or may advertise themselves, at low cost, for things wanted; things they have for Sale, for Trade, for Sale or Trade. This is an excellent forum for acquiring or disposing of such items as binoculars, books, cameras and photographic equipment, magazines, sports and outdoor equipment, etc.

GENERAL REQUIREMENTS APPLICABLE TO CLASSIFIED ADVERTISING

1. *Transactions based on good faith:* Transactions are based on good faith and mutual satisfaction. Deliberate misrepresentation, disregard of usual business ethics or the attempt to circumvent these general requirements, when brought to our attention, will result in refusal of further advertising.

2. *All orders subject to these conditions:* We reserve the right to edit all copy to conform with our standards and to reject or discontinue any advertisement which we consider undesirable.

3. *Who may advertise:* This department is an open market trading post. Any individual or firm whose advertisement and methods of doing business meet our requirements may advertise their goods or services.

4. *Rates:* All classified advertisements must be accompanied by remittance. The rate is 15c per word including name and address—minimum charge $2.00. Cash with order.

5. *How to count numerals, etc.:* Groups of figures are counted as one word. Abbreviations consisting of initials or single characters likewise are counted as one word. Hyphenated words are counted as two words.

6. *"For Sale" ads must state prices:* A specific price must be stated on all FOR SALE ads —except that the phrase "write for catalog" may be used when listing real estate or merchandise in quantities.

7. *Conditions of trade or sale:* The condition of binoculars, cameras, instruments, other equipment useful to outdoor lovers, home-owners, etc., advertised for sale or trade must be specified as follows: PERFECT—meaning factory condition; EXCELLENT—meaning new condition. implying negligible amount of use; VERY GOOD—meaning practically new condition, implying little use. with no appreciable wear and only minor surface scratches or wear; GOOD—meaning moderate condition and with only moderate wear; FAIR—meaning no parts missing necessary to use, reasonable wear inside and out; POOR—meaning marred appearance or badly worn.

8. *Non-specific phrases barred:* Phrases such as "highest" or "top prices paid", as well as any other so-called "auction-type" phrases are not acceptable. The terms "fair price paid" or "state price wanted" may be used.

9. *Blind ads not acceptable:* Box number or blind ads will not be accepted. Give your complete name and address to insure prompt delivery of all mail or telegraph replies.

10. *Requesting privilege of examination:* Purchasers desirous of examining merchandise before acceptance should request shipment by express C. O. D. with examination privilege. This procedure permits the purchaser to inspect the merchandise in local express office and authorizes the express company to return unsatisfactory merchandise at shipper's expense.

11. The association will not accept for publication in NATURE MAGAZINE, advertisements of firearms, ammunition, or patent medicines.

12. *Responsibility for illegible copy:* Type or print advertisement plainly as we cannot be responsible for errors due to illegible writing.

13. *Closing date:* The closing date of all advertisements is the 20th of the second month preceding month of issue.

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AUTOMOTIVE

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"RUTHBELLA" (Sansicchi)—handy reprint edition of this famous Love Diary now available, price $2.00 postpaid. Listing "Lonely Hour Books" included. Poets Corner Press, Publishers, 309-3, Palisades Park 11, N. J.

BOOKS

SECURE your out of print and second hand books from The Audubon Book Service, 415 Lincoln Ave., Brooklyn 8, N. Y.

NATIONAL GEOGRAPHIC MAGAZINES 1888 —1947, any issue. Free literature. Periodical Service, Box 327-N, Swarthmore, Pennsylvania.

NATURTARIAN PAPER 10¢. Thrilling Nature book $1.00. Frost, R. No. 2, Arcadia, Florida.

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60 POWER TELESCOPE, $2.95. 250 power microscope, $2.45. Send for free catalog of Telescopes, Binoculars and Microscopes. Brownscope Company, 24 West 45th St., New York.

TELESCOPES, BINOCULARS, MICROSCOPES, Photographic equipment, Barometers, Hygrometers, Magnifiers, Scientific books. Buy, sell, repair. We guarantee. Lists 10¢. Specify instrument wanted. Rasmussen and Reece, 41 Market St., Amsterdam, N. Y.

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GENEALOGY

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HOBBIES

EARTHWORM CULTURE. A fascinating hobby; profitable home industry. Write for valuable free bulletin-review on "Earthworms: Their Intensive Propagation and Use."—Thomas J. Barrett, Earthmaster Farms, Box D-488, Roscoe, California.

LEATHERCRAFTERS! Send for catalog listing leathers, kits, supplies. Kit Kraft, Dept. A, 1607 South Western Ave., Los Angeles 6, Calif.

HOBBY CATALOGUE 10¢. Biological Supplies, Publications, Curios. Two gallon Aquarium $2.50; five gallon $3.75. Twenty glass miniature animals $2.00. Specimen Forceps 12" $2.75. Mexican toy tarantula 35¢. Quivira Specialties, 4010 W. 21st Street, Topeka, Kansas.

THERE'S TRADITION IN THE PINE GUM

(Continued from page 76)

is nothing but turpentine and water, and carries it through a tub of water into a separator. At the separator the water sinks to the bottom; the turpentine rises to the top. Through automatic means, the water is drawn away from the bottom, while at the same time the turpentine is removed from the top. This gum turpentine, a colorless, limpid, aromatic liquid, is run into barrels or tank cars for shipment to large storage tanks.

The remainder of the mixture is just a modification of resin acids, resenes or rosin, together with some needles, bits of bark and chips left in the vat. Foreign matter is removed by passing the molten resin through a series of wire strainers, sometimes through layers of cotton batting supported on a wire screen. The final molten resin is run into wooden barrels, metal drums, tank cars or even multiple-ply paper bags.

There are 13 grades of resin, classified by color, each grade having a trade name. Ranking first is the lightest shade, known as "X," then follow Window White, Window Glass, Nancy, Mary, Kate, Isaac, Harry, George, Frank, Edward, Dolly, and, finally, Betsy, which is a reddish-black hue.

Gum derived from the living tree comprises about 65 percent of the product and is called "gum" naval stores. The other 35 percent is gathered from several other sources, such as resinified stumps and "lightwood," the resinous wood remaining after the sapwood has rotted off. This is termed "wood" naval stores, processing of which is rather colorful and extensive.

Varied products are made from turpentine and resin. Turpentine serves as a thinner for paint and varnishes; solvent for resins in lacquers and varnishes; in pharmaceuticals; as disinfectants; in liniments; in polishes, of various kinds; in insecticides; for bleaching bones for buttons, and other purposes. Resin is used for laundry soaps; in sizing of paper; in paper board and wall board; gloss oils, paints, and waxes of all kinds; on sticky flypaper; in fireworks, cements, plastic wood; on violin bows; and has many other commercial uses.

It is a striking fact to newcomers, or to travelers passing by these large pine forests, that such a tremendous yearly output is realized from them. The United States Forest Service has found that this country can produce annually, on a sustained yield basis, 800,000 barrels of gum turpentine, and nearly 3,000,000 barrels of gum resin. The current annual yield of turpentine is about 250,000 barrels, and of wood resin about 1,000,000 barrels.

Naval stores are also produced in France, Russia, Portugal, India, Spain and Mexico, but the United States produces more than half of the world's supply. Normally, about 50 percent of the United States' production of naval stores is exported, with the United Kingdom the largest foreign consumer.

As time has marched on, the progress of industry has carried a time-old product far beyond its original usage. Naval stores have come into wide and varied use, indeed, almost everywhere but by the Navy. Yet in the traditional name of "naval stores" live the aroma of pine gum, and the picture of wooden boats plying the seven seas, manned by "jolly Jack-tars" with oakum on their pigtails.

WHAT IS HAPPENING TO OUR ATLANTIC OYSTERS?

(Continued from page 93)

Summing up the situation in Rhode Island, Mr. Gibbs said: "The Legislature has failed to see that the problems of control are urgent in a small state where there is intense use; depletion of some stocks of shellfish is already here; laws must fix size as well as quantity; and 'teeth' must be placed in law enforcement."

Mr. Gibbs hinted that there are changes in water conditions but just what these changes are no one knows. Quite recently the Fish and Wildlife Service began a survey of Rhode Island's waters to learn more about them.

"The shellfish resources of the (Middle-Atlantic) region," the Service says, "great as they are, suffer from lack of management by modern, scientific methods in many parts of the area. This is largely because, with few exceptions, the practice is to harvest the crop from the public grounds with little or no provision for replenishment—with no systematic cultivation."

A hopeful note is seen in the fact that Maryland and Virginia and the Service have joined forces in a cooperative program to restore the sadly depleted oyster fisheries of the Bay. The magnitude of the loss of Maryland's oyster production has been estimated as equivalent, in terms of protein food, to the loss of a herd of about 160,000 head of big steers —far more than are now produced on the farms of the state.

It is plain enough why the catch of Atlantic oysters is on the decline. Happily, some progress is being made to remedy unfavorable conditions. But what a big job lies ahead!

Albert M. Day, Director, Fish and Wildlife Service, had this to say anent the dwindling oyster production along the Atlantic Coast: "Whether the fisheries will realize their full importance and value to the area and to the nation depends on the character of the conservation program followed in future years."

HARRY ALLARD'S DAY

(Continued from page 80)

ing in many directions seems to have a bearing on this happening. Harry Allard's varied probings continued. In 1917 and 1918 he wrote for several journals. Tobacco diseases and abnormalities got much of the attention in the formal research work, but there was the usual crop of hobby reports on the behavior of various creatures. There were three Allard papers in 1919—"Some Studies in Blossom Color Inheritance in Tobacco"; one on Mendelian behavior of a tobacco cross; and one on a tobacco plant condition called gigantism.

And then in 1920 came the report of the joint discovery by Dr. W. W. Garner, chief of the Division of Tobacco Investigations, and Mr. Allard, published in the *Journal of Agricultural Research,* which announced what is now known as a fundamental law of Nature that the blossoming and fruiting of plants is dependent upon the length of day (or night)—what is known as photoperiodism. The paper was entitled "Effect of the Relative Length of Day and Night and Other Factors of the Environment on Growth and Reproduction in Plants." There was another paper on the subject the same year by Garner and Allard in the Smithsonian Report, and one in the U. S. Department of Agriculture Yearbook. Still other reports on various phases of photoperiodism in plants were published by the two coworkers in 1922, 1923, 1924, 1925, 1926, 1927, 1928, 1930, 1931, and some still later. During all these years of most productive fundamental research on the relationship of plants to the length of day, Allard, sometimes alone and sometimes with others, continued to reach out for new facts about all sorts of things in Nature.

Now that he has retired from the Department and formal research, Mr. Allard, who has shed much light on the place of light and illuminated the dark in many ways, is still on the trail of new facts. Over hills and through the woods he will hear the drumming spiders and the singing toads, and will likely add much more to what we know about a hundred phases of Nature.

The new knowledge of the length of day has borne results in commercial horticulture and has led to ever widening research on the subject in scores of scientific institutions.

Few men have looked at the sun as unblinkingly as Harry Allard.

Humane Movies

The American Humane Association, 135 Washington Avenue, Albany 6, New York, announces the renewal of its annual amateur motion picture contest for films of pets, domestic animals, birds and wildlife. Cash awards totalling $300 are offered, and details may be obtained at the address given above.

HOBBIES

$10,000,000 FREE—ANNUALLY—prize contests. You can win fortune. Expert help. Free nationally advertised gifts to patrons. Bulletin free. Cash Register-X, 210 Fifth Avenue, New York 10, N. Y.

WHITTLING PATTERNS, 50 assorted figures 25¢ complete circus 25¢. Horses for experts 25¢ Pattern Service, P. O. Box 1312, Lancaster, Penna.

EARN MONEY AT HOME—Assemble colorful handmade jewelry! Free details. Beginner's outfit, $1.00 (refundable). Plastic Works, 712 Kimball, Danville 18, Illinois.

HOME MOVIES

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Under the Microscope

By JULIAN D. CORRINGTON

THE USE OF FIXERS

ALMOST the first step in the processing of organic material for slide preparation is fixing, well known to all technicians. Many persons fall into the easy habit, however, of employing the same fixer for all purposes, hence a brief discussion of the possibility of using several of the standard formulas may be welcome.

Actually the first step, after acquiring the specimen, is killing, and in microtechnique this term applies to the cells and tissues rather than to the whole organism. Following fixing and washing, the next act is hardening. In practice, though, all three requirements, killing, fixing, and hardening, are done by the same reagent, and the procedure is simply called fixing, using the term in a broader sense.

A fixer must accomplish a number of different objectives. First of all, it must permanently *preserve* the tissue against later decay. Satisfactory preservation must take place before any post-mortem changes can occur, and hence it must be rapid and thorough. The need for rapidity involves the element of *penetration*, while a third requisite is *optical differentiation*, by which is meant the raising of the optical index of various tissue components to different degrees so that they are not all of the same degree of transparency and refract light in a manner that introduces contrast in the final view under the microscope.

The only single reagents that combine these features to any satisfactory degree are absolute alcohol, used mainly for Nissl's method with nervous tissue and for the aorta to demonstrate elastic tissue, and 10% formalin, which can be employed as a general fixer, but is especially indicated for fat, myelin, microchemical tests, brain and spinal cord, and for the freezing method of sectioning.

For most purposes, good fixers are mixtures of different chemicals, some useful for one or two of the requirements, some for others. Thus, in Zenker's fluid, one of the best known standard zoological fixing agents, potassium bichromate, bichloride of mercury, and acetic acid all confer varying degrees of optical differentiation; the first two preserve; the bichromate hardens; the bichloride shrinks while the acetic swells, thus each counteracting the other in this respect; and the acetic is the most powerful penetrator in common use, carrying the other ingredients in with it. The use of sodium sulphate in this formula is unknown, but many workers feel that the mixture works better with than without it.

Fixing proper—that is, preservation—is most often accomplished by a metallic salt, and the action involved is not always understood. Sometimes the salt enters into a direct chemical combination with elements in the tissue, some of which are permanently precipitated in altered form; sometimes the fixer acts by coagulation, with an irreversible change, as when white of egg is coagulated by heat from a colorless fluid to an opaque white solid. There is always some question, in the final product, as to whether the structure seen under the microscope is actually present as such in the living material, or whether it may not rather be due to the coagulating or precipitating of some fluid substance to produce an *artefact*—an unnatural appearance. Thus, there is still a controversy as to whether or not muscle fibers possess longitudinal fibers of a secondary order, termed fibrillae or myofibrillae. Some say these form only in fixed material, due to the reagents employed.

Among standard fixers incorporating bichloride of mercury, other than Zenker's, is Schaudinn's fluid, bichloride plus alcohol, widely used in fixing protozoa, and Gilson's fluid, bichloride plus nitric acid, for general use, preferred by many to Zenker's. Bichromate of potassium is combined with acetic acid alone in Tellyesnicky's fluid, more or less of universal preferment in embryology, especially amphibian. The Zenker-formalin mixtures use bichromate, bichloride, and sodium sulphate, but substitute formalin for the acetic acid. One of these is Helly's fluid, and a stronger one is Maximow's, both recommended when the cytoplasmic structure of cells is the main object of the investigation. Without the bichloride, this combination becomes Orth's fluid, rapidly coming to the front as a general fixer and recommended especially for nervous tissue. Bichloride, with both formalin and acetic acid, yields Worcester's fluid, considered superior by many for protozoa, embryology, and nervous tissue.

An entirely different type of fixer is based upon picric acid, a preserver and differentiator. As with other reagents, it is better in mixtures than alone, and the most important formula is Bouin's fluid, a "fool-proof" solution in that one cannot overfix in this liquid and it is difficult to go wrong in its use. As one histologist put it, "When in doubt, use Bouin's." This reagent adds formalin and acetic acid to picric and is an excellent general fixer, but is not advised for cytological detail. When picric is combined with sulphuric acid, the mixture is termed Kleinenberg's, and is the favored one for chick embryos.

For chromosomes, the time-honored fixer incorporates the very poisonous and likewise very costly osmic acid. The best mixtures are called Flemming solutions, for which there are several formulas and modifications, using chromic acid, acetic acid, and osmic acid, abbreviated as the chrom-acetic-osmic mixtures.

For general purposes, botanists prefer FAA, formalin-acetic-alcohol, often called the universal fixer. It is especially good for field collecting, as it fixes and also preserves indefinitely, material left in it for months showing no ill effects. As would he expected for a sort of "rough-and-ready" fixer, FAA is not considered when fine cytological work is planned. Zoologists like a modification of FAA termed Lavdowsky's fluid, while, for insect larvae, Kahle's fluid is a better arrangement.

This is far from being a complete list of fixers, the number of published formulas running into the thousands. Enough of the favorites have been given, however, so that the technician can try out several and compare them as to results. Space does not permit inclusion of all the formulas, which may be found in any standard manual.

It is not a matter of indifference as to how fixers are washed out in the immediate after-treatment. Most of them should be washed in running tap water, but not those containing picric acid, or in which formalin constitutes a major ingredient; these should be washed in 70% alcohol, several changes. Water at any stage seems to undo more or less of the work of fixation by picric acid, hence alcoholic stains are generally preferred to aqueous ones after picric fixation.

Fixers made with bichloride of mercury need an additional step in the washing process, stressed in all manuals—the addition to one of the alcohol series of a small amount of iodine. This may be either the tincture, or Gram's or Lugol's solutions, as used in bacteriology. Most often the 70% alcohol is chosen and the directions invariably read to "add iodine solution to give the alcohol a port-wine color." This prevents the formation of mercury "pins" in the tissues. After washing out the iodinized alcohol in fresh 70% alcohol, the dehydration continues as usual.

As to volume, fixers should be used in liberal amounts; not less than 10 times the bulk of the tissues to be fixed. and not

over 100 times. It is better to err on the side of too much rather than too little, and a rough estimate of from 50 to 100 times the volume of tissue will be found wisest.

Fixers are never used twice. Stains, alcohols, and other reagents may be employed many times, until too dilute or contaminated, but fixers are used once, then discarded. Many of them are best made up fresh, especially the osmic acid mixtures. Any convenient form of glassware is suitable as the vehicle for fixing, wide-mouthed bottles and jars being favored.

For length of time of fixing, refer to manuals. In general, a fixer including bichloride of mercury must be employed for a specified time, and can easily overfix, whereas picric or formalin mixtures, as Bouin's or FAA, do not overfix. Use small pieces of tissue, remembering that the fixer must penetrate rapidly to all parts for effective service. The beginner often makes the mistake of trying to fix relatively large parts or even whole organs. If a large portion is wanted in one plane, see that the piece is thin in another plane: e.g., a whole kidney of an animal as large as a cat may be sectioned, but when the organ is removed, slice it so that the piece placed in the fixer is not more than one-quarter inch thick, allowing satisfactory penetration of the large area. Capsules are often rather impervious, being made of dense connective tissue, and if an entire organ is to be fixed, the capsule should be removed, at least in places, or incisions made to give access for the fluids. As further examples, a hollow organ, as small intestine of cat, should be cut squarely across in two places, approximately one-half inch apart; several such pieces will fix better than one long piece. With a solid organ, as the spleen or liver, the piece cut out for fixing, the cuts perpendicular to the surface and to the long axis of the organ so as to avoid oblique sections, should measure about $\frac{5}{8}$ by $\frac{5}{8}$ by $\frac{1}{4}$ inch, or less. A salivary gland or other small organ may come within these dimensions, but it is better to cut the gland in two pieces and fix both, rather than place the entire gland in the fluid. Speed of penetration for fixing before postmortem changes occur is the guiding principle in all these cases.

TRADE NOTES

Slide Storing Addendum to our article on filing microslides: the Technicon Company, 215 East 149th St., New York 51, N. Y., has called our attention to their Lab-aid flat-filing microslide cabinet unit, which contains fifty flat trays, each holding sixteen slides, or thirty-two if placed back-to-back, giving a total capacity for each unit of either 800 or 1600 slides, filed in flat position. This unit is of the same construction as those previously discussed and stacks in with them in various combinations, as desired, or may be placed separately on the desk.

Anatomy An excellent laboratory manual for mammalian anatomy is *The Dissection of the Cat*, by Harold M. Messer, well-known teacher of comparative anatomy at Long Island University. Features are: description according to systems of organs; sufficient but brief identification of the named structures, with suggestions or clues as to where they are to be found, placing part of the responsibility on the student, to develop initiative; adequate directions for dissection, so that no other book is required in the laboratory; straight descriptive anatomy without textual material on morphologic history, which is left to the home study of appropriate texts; complete coverage, with the nervous system fully dissected, a subject often skimped; fourteen outline drawings to be completed as well as labeled, a time-saving feature which the author has wisely not overdone; many drawings are to be made in their entirety by the student; note-book size, wire binding, for flat opening in laboratory use; large readable type, pleasing format, and proper choice of boldface and small capitals, for emphasis.

An excellent manual, written by a teacher of wide experience, and carefully tested in actual use. Recommended for all who teach a course in the dissection of the cat, or for the individual who wishes to undertake this study at home. Pp. vi, 59; figs. 14. Ziff-Davis Pub. Co., Empire State Bldg., 350 Fifth Ave., New York 1, 1945. $1.50.

Bacteriology Textbooks of the explanatory type are essential for beginning courses. The historical and philosophical approach may be used in books designed for the second or further courses in a subject, in addition to further exposition. But for advanced treatment, a reference work, a compilation of thousands of research papers, is required. Such a volume must be critical in both inclusion and exclusion of material, and must discuss and compare results and their values, taking a long-time view of the growth of a subject. This sort of writing must be done by an author who has broad training and experience in his field; one who can bring the needed critical evaluation to the weeding-out process, and who has the authority to speak to colleagues of equal prominence, though perhaps of different specializations, as well as to students who seek guidance in discriminating the worth of numberless separate reports.

Bacterial Chemistry and Physiology, by Professor John Roger Porter, of the College of Medicine, State University of

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Iowa, is a comprehensive and scholarly work of this last type. It is designed for advanced undergraduate and graduate courses, and as a reference volume for bacteriologists, biologists, chemists, pharmacists, and all others whose interests concern microorganisms. The ten chapters treat of the physico-chemical properties of bacteria and their environment, the growth and death of bacteria, the effects on them of physical and chemical agents, their chemical composition, their enzymes, respiration, and nutrition, the metabolism of carbon and of nitrogen compounds by microorganisms, and microbial fermentations. Each chapter is well documented with references, and there is both a microorganism index and a subject index. An immense amount of valuable information is included, handled in masterly fashion, and thoroughly up to date, with charts, graphs, tables, flow sheets, and other aids. Pp. x, 1073; figs. 13, tables 21. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, 1946. $12.00.

Embryology A biological classic is now out in its fifth edition, considerably rewritten and improved. Dr. Leslie Brainerd Arey's *Developmental Anatomy* is the most celebrated human embryology in English and has long been a cornerstone in premedical and medical courses. As in previous editions, the first section deals with general embryology and early stages, the second with organogenesis, and the third is a laboratory manual for the study of chick and pig embryos. The presentation, combining structural, functional, and pathological details, is unrivaled, and the illustrations both numerous and excellent.

In the fifth edition, many of the older cuts have been improved and many new illustrations added. Most of the first section has been rewritten, enlarged and improved, with new discussions on growth, histogenesis, maturation, cleavage, gastrulation, human embryos and their membranes, and the placenta. Entirely new chapters include those on reproductive cycles and their control by hormones, and on experimental embryology. This text is now more useful than heretofore for undergraduate courses in general embryology.

The general reader will find this work an unsurpassed presentation of the subject and the illustrations will aid greatly in clarifying technicalities. Pp. ix, 616; figs. 588, many in color. W. B. Saunders Co., West Washington Square, Philadelphia 5, 1946. $7.00.

HISTORICAL OUTLINE

When bacteriology is mentioned, the average person thinks at once of the medical division of this subject. While undoubtedly of highest importance to the individual in relation to many serious diseases, and to the community when epidemics threaten, there are many other phases of this science, and some of them are more fundamental than the medical, involving even so basic a matter as the possibility of plant, animal, and human life on this planet.

In 1893-94, the Russian worker, Serge Winogradsky, demonstrated that atmospheric nitrogen is fixed in the soil by the anaerobic bacterium, *Clostridium pastorianum,* while the Dutch bacteriologist, Martinus Beijerinck, in 1901, discovered the aerobes, *Azotobacter chroöcoccum* and *A. agilis,* that also accomplish this important capture. As Frobisher puts it, this process is of absolutely fundamental importance to the human race, for without it there would be no human race! With Omeliansky and still other investigators, these two went on, in the years following 1895, to work out the process of nitrification, whereby ammonia, formed in the soil by various biological processes, such as the decomposition of vegetable and animal matter, is oxidized through successive stages, first into nitrites by the soil bacteria, *Nitrosomonas* and *Nitrosococcus,* and then into nitrates by *Nitrobacter.* Neither ammonia nor nitrites can be utilized by plants in building up their proteins, only the end product, nitrates, and when these have been exhausted from the soil, the farmer must replace them as fertilizers, or add materials from which nitrates can be made by the soil bacteria. Thus, when manure is spread on the soil, ammonification—the formation of ammonia—is performed by ammonifying bacteria, and the cycle starts that ends in nitrates which the plant root hairs absorb in weak solutions. Some common ammonifying species are *Bacillus subtilis, Proteus vulgaris,* and *Sarcina lutea.*

The German chemists, Hellriegel and Wilfarth, in 1888, discovered a species of nitrogen-fixing bacterium that lives symbiotically with legumes, forming root nodules or tubercles in which they store up nitrogen taken from the atmosphere. Details of the chemical changes and utilization are obscure, as also the question of number of species involved. Beijerinck gave the name *Bacillus radicicola* to the first-discovered organism, and some authorities claim today that there is but a single species, now called *Rhizobium leguminosarum,* with several strains; others think there are two species, with different culturing characteristics, *R. leguminosarum* and *R. radicicola,* and still others specify six or more species.

Here lies the scientific explanation for practices that antedate the discovery of the reason for doing them—crop rotation, and the ploughing under of clover, soybeans, and other leguminous crops as a relatively inexpensive method of fertilizing the soil. From the scientific point of view, all agriculture rests upon a foundation of bacteriological knowledge, and soil bacteriology is today a very prominent division of the general subject.

Emil Kristian Hansen (1842-1909), Danish chemist and biologist, became the chief investigator in the celebrated Karlsberg Laboratory, established by the brewer, Jacobson, for research on fermentation. Hansen succeeded in isolating a single yeast cell (the entire yeast plant is a single cell) in order to establish a pure culture. In this fashion he produced numbers of pure lines from which could be chosen those with desirable characteristics. He founded the accepted techniques of the present day, reforming the brewing industry, and has contributed much to the commercial manufacture of yeasts and to our knowledge of enzyzmes and the role they play in the fermenting process.

It will be recalled, by readers of this series, that the great German chemist, Liebig, fought for his theory that fermentation was a chemical process, and that he was finally defeated by Pasteur through convincing experiments proving the phenomenon due to microorganisms. Eduard Buchner, professor of chemistry at Berlin, added a new chapter to this work when, in 1897, he succeeded in grinding up yeast cells and securing an extract that would change sugar to alcohol and carbon dioxide. He thus showed that carbohydrate fermentation was not caused directly by some "vital" action of the protoplasm of the yeast plants, but that these cells produced a chemical substance which performed the "yeasting." The substance was identified as an enzyme, a word which means "in the leaven," equivalent to saying "in the yeast," and was given the name zymase. Today it is known that the so-called zymase is actually a mixture of enzymes, no one of which alone can form the alcohol, but the word is still retained for convenience. Zymase may be extracted and used separately, whereupon fermentation occurs as usual, but without the presence of yeast plants.

Many other industrial processes depend upon similar action by microorganisms. Industrial ethyl alchohol is made by yeast from sugarcane molasses, beets, potatoes, or other cheap carbohydrate sources; glycerine is obtained from glucose by aid of the yeast, *Saccharomyces ellipsoideus;* acetone and butyl alcohol are made from carbohydrates through the action of *Clostridium,* especially *C. acetobutylicum;* citric acid manufacture employs the fungus *Aspergillus niger* and related species; rubber latex is coagulated by *Bacillus pandora* and others; and so on through a long and growing list.

Because of its value to students in departments of biology, botany, zoology, bacteriology and parasitology, and as reference material for teachers, "Vocabulary for Parasitology and Public Medicine" is now separately available at three dollars a hundred.